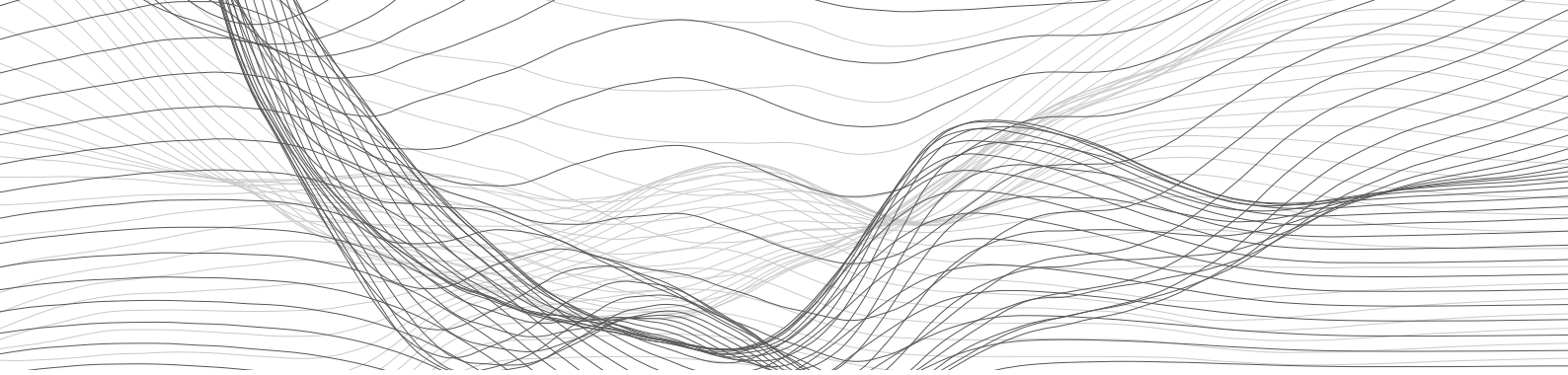


On the transmission of monetary policy to the housing market

Winfried Koeniger, Benedikt Lennartz, Marc-Antoine Ramelet

SNB Working Papers
6/2021

SCHWEIZERISCHE NATIONALBANK
BANQUE NATIONALE SUISSE
BANCA NAZIONALE SVIZZERA
BANCA NAZIUNALA SVIZRA
SWISS NATIONAL BANK

Legal Issues

ISSN 1660-7716 (printed version)
ISSN 1660-7724 (online version)

On the Transmission of Monetary Policy to the Housing Market *

Winfried Koeniger[a] Benedikt Lennartz[b]
Marc-Antoine Ramelet[c]

February 19, 2021

Abstract

We provide empirical evidence on the heterogeneous transmission of monetary policy to the housing market across and within countries. We use household-level data from Germany, Italy and Switzerland together with the respective monetary policy shocks identified from high-frequency data. We find that the pass-through of monetary policy shocks to rates of newly originated (fixed-rate) mortgages is twice as strong in Switzerland than in Germany and Italy. After an accommodative monetary policy shock, this is associated in the housing market with a larger immediate, and persistent increase of transitions from renting to owning; a stronger decrease in rents; and an increase of the price-rent ratio. Within Italy, we find a stronger pass-through to mortgage rates, housing tenure transitions and the price-rent ratio in the northern regions that have been characterized in the literature as more financially developed than the southern regions.

Keywords: Monetary policy transmission, Housing market, Home ownership, Rents, House prices.

JEL-codes: E21, E52, R21.

*We thank an anonymous referee, colleagues and participants at seminars and conferences for their helpful comments; Oliver Krek for research assistance; and Peter Bolliger for the helpful discussions on the HABE dataset. This paper contains substantially revised results previously circulated with the working title "Home Ownership and Monetary Policy Transmission." The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the author(s). They do not necessarily reflect the views of the Swiss National Bank (SNB). The SNB takes no responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper.
a: University of St.Gallen, CESifo, CFS, IZA; Address: Department of Economics, University of St.Gallen, SEW-HSG, Varnbüelstrasse 14, 9000 St.Gallen, Switzerland, winfried.koeniger@unisg.ch;
b: Department of Economics, University of St.Gallen, SEW-HSG, benedikt.lennartz@unisg.ch;
c: Swiss National Bank, marc-antoine.ramelet@snb.ch.

1 Introduction

The transmission of monetary policy is at the core of the research agenda in economics. Much research has focused on the response of consumption and output to shocks to the policy rate (Galí, 2015). Recent research by Calza et al. (2013) and Corsetti et al. (2020) has documented a sizable heterogeneity of monetary policy transmission across euro area countries, and that this heterogeneity is associated with differences in the housing market.

We contribute to that literature by providing evidence at the household level on the transmission of monetary policy to the housing market. We focus on Germany, Italy and Switzerland, which differ in at least two important dimensions: (i) the size of the market for rental housing and its ownership structure and (ii) the indebtedness of new homeowners and the characteristics of the mortgage market. We explain in Section 2 that these dimensions matter for the transmission of policy rate shocks to the homeownership rate and the price-rent ratio because they affect the pass-through to the rental price of housing units and the user cost of owning a home.

We estimate the transmission to the housing market using household-level data together with monetary policy shocks identified from high-frequency data. Our use of household-level data has the advantage that we can analyze transitions (gross flows) across housing tenure states of individual households, together with the pass-through of the policy rate shocks to rents and housing values. Analyzing the differences in the pass-through across households yields insights on the causes for the heterogeneous transmissions across countries.

We find that the pass-through of an unexpected change of the policy rate to rates of newly originated (fixed-rate) mortgage rates is about 80% in Switzerland but only half that in Germany and Italy. After an unexpected reduction in the policy rate by 25 bp, transitions from renting to owning a home increased by $1-2$ pp in Germany and Switzerland but not in Italy, whereas transitions from owning to renting increased by 0.5 pp in Switzerland but not significantly in the other countries. These effects on the gross flows for Germany and Switzerland are quantitatively important, as illustrated by considering a policy rate shock of one standard deviation. Then the effects on the transitions previously mentioned must be scaled down by approximately one third because the standard deviation of the monetary policy shocks is 7 bp for the European Central Bank (ECB) and 10 bp for the Swiss National Bank (SNB). The resulting effects on the transitions remain sizable given that the average rate per year, at which households change housing tenure from renting to owning for the considered countries, is 4 percent and the average rate per year, at which households change from owning to renting, is $1-2$ percent.

The implied increase in the net flow toward owning after a policy rate reduction in Germany and Switzerland is associated with a stronger increase of the price-rent ratio in

Switzerland than in Germany and Italy. Rents decrease by 3.5 percent in Switzerland but we do not detect significant decreases in rents for the other two countries. We provide suggestive evidence that public ownership of rental housing, which is less important in Switzerland than in Germany and Italy, together with the indexation of rents to mortgage interest rates in Switzerland, as described further in Section 2, may explain the different response of rents across countries.

We uncover the regional heterogeneity of the pass-through to the mortgage rate *within* Italy, which is associated with differences in financial development. We find that an unexpected interest rate reduction triggers more transitions to homeownership and a stronger decrease of rents in more financially developed Italian regions. From a methodological point of view, the regional heterogeneity within Italy allows for an alternative identification of monetary policy transmission to the housing market. Both the results across countries and across regions within Italy illustrate how differences in the pass-through to mortgage rates are associated with differences in the transmission to housing tenure transitions, rents and price-rent ratios.

These results are of interest because monetary policy transmission to quantities and prices in the housing market matters not only for the housing market itself but also for the response of aggregate non-housing consumption. The implied distributional effects across renters and mortgagors, for example, affect aggregate consumption because these subgroups of the population differ in their marginal propensity to consume (Cloyne et al., 2020). Hence, from an applied theoretical perspective, our results provide targets for the considered countries that help to discipline quantitative models with housing which attempt to capture these distributional effects, along the lines of recent research, e.g., by Kaplan et al. (2020), Hedlund et al. (2016), Wong (2019) for the U.S., or Kaas et al. (2021), Hintermaier and Koeniger (2018) for countries in the euro area.

Monetary policy transmission to rental prices in the housing market also matters for changes of the consumer price index, a key target of central banks. Indeed, Dias and Duarte (2019) show for the U.S. that the consumer price responses to monetary policy shocks are much stronger if the price for shelter is excluded because rents *decrease* after an (expansionary) unexpected reduction in the policy rate. Our analysis suggests that this effect is particularly relevant for Switzerland where rents decrease strongly after policy rate reductions and the incidence of renting is high, and less so for Germany where public ownership of rental units seems to mitigate the pass-through of monetary policy shocks to rents. The latter also applies to Italy where, in addition, the incidence of renting is much lower than in Germany and Switzerland (see Section 2).

The empirical literature on the transmission of monetary policy to the housing market is small compared with the vast literature on consumption responses (Piazzesi and

Schneider, 2016). Beraja et al. (2018) and Wong (2019) focus on the mortgage refinancing channel for consumption responses which is important for the U.S. where refinancing is not as costly as in the countries we analyze (see Section 2). We refer to Cloyne et al. (2020) for a concise overview of the recent literature. Cloyne et al. (2020) estimate heterogeneous consumption responses across housing tenure groups and show how these responses relate to the different balance sheet positions of these groups.[1] They do not find an economically and statistically significant effect of monetary policy shocks on housing tenure shares in the U.S. and U.K. (see their online appendix). Fuster and Zafar (2021) find small effects of changes in financing costs on the willingness to pay for house purchases, based on a strategic survey in which respondents in the U.S. revealed their behavioral responses to hypothetical changes. Using high frequency identification of monetary policy shocks for the U.S., Dias and Duarte (2019) find instead that the homeownership rate and house prices decrease whereas rents increase after a contractionary policy rate shock.

Given the differences of housing markets across countries, the external validity of the U.S. evidence is limited. The aggregate evidence for the euro area by Corsetti et al. (2020) shows that important differences exist in the monetary policy transmission to the housing market across countries and that this heterogeneity matters for consumption responses. Our focus on three European countries allows us to analyze in greater detail the transmission to the housing market because we can provide disaggregate evidence on household transitions (gross flows) across housing tenure states and the response of rents and, for Germany and Italy, also house prices at the household level. Household-level data allow us to uncover heterogeneous effects on housing tenure transitions across population groups with different ages, incomes and net worth which provide useful targets for structural models of the housing market.

We have motivated the choice of countries for the analysis mentioning key differences in housing markets across these countries. Switzerland, which participates in the single European market with a monetary policy independent of the euro area, provides for an interesting comparison with Germany and Italy. Considering Italian- and German-speaking households within Swiss regions, allows us to assess the behavioral differences in that comparison that may be associated with culture, and that have been found to be relevant in research on household finances and housing (Haliassos et al., 2017). We find little evidence for different responses of housing tenure transitions to monetary policy shocks across language groups in Switzerland. This lack of evidence suggests that the cross-country differences in the monetary policy transmission to the housing market, which we report in this paper, are the result of institutional differences across regions,

[1] Slacalek et al. (2020) gauge the importance of balance sheet effects in the euro area. Collateral constraints, as emphasized by Iacoviello (2005) for example, imply that the response of house prices to expansionary monetary policy shocks may amplify the consumption response.

such as the practice of benchmarking rents to the mortgage rate in Switzerland, rather than culture.

We find that the responses of the homeownership rate, rents and house prices differ across regions with a different ownership structure of housing units. These results relate to the argument of Greenwald and Guren (2019) who show that the response of the homeownership rate to changes in credit conditions should be relatively stronger than the change in the price-rent ratio in regions with less segmented housing markets, i.e., in regions where more of the housing stock is owned by large deep-pocket investors. In our analysis, an unexpected reduction of the interest rate reduces the cost of financing homes and thus improves credit conditions for households. In Section 4 we show in detail how monetary policy shocks pass through to yields of bonds with different maturities and to mortgage rates in each of the considered countries.

We identify monetary policy shocks using high frequency data. This approach, pioneered by Cook and Hahn (1989), Cochrane and Piazzesi (2002) and Kuttner (2001), exploits the fact that data on futures or swap contracts contain information on market expectations about monetary policy. The identification of monetary policy shocks then uses the discontinuous changes in these expectations in a short time window around the monetary policy announcements. Recent applications of this approach are in Gertler and Karadi (2015) and Nakamura and Steinsson (2018) for the U.S., Gerko and Rey (2017) and Cesa-Bianchi et al. (2020) for the U.K., Altavilla et al. (2019) and Corsetti et al. (2020) for the euro area, and Ranaldo and Rossi (2010) for Switzerland.

Our analysis proceeds in the following steps. In Section 2 we briefly describe important features of the housing and mortgage markets in Germany, Italy and Switzerland, and we explain why these features matter for monetary policy transmission. We then discuss in Section 3 how we identify exogenous policy rate movements. In Section 4, we analyze the pass-through of the monetary policy shocks to long-term interest rates, and in particular to mortgage rates. We then present the household-level data for Germany, Italy and Switzerland in Section 5. In Sections 6 and 7, we estimate the responses of housing tenure, rents and the value of housing. In Section 8, we provide results for these responses across Italian regions before concluding in Section 9.

2 Housing markets and monetary policy transmission

Household portfolios, particularly homeownership rates and household debt, differ widely across countries (see, for example, Christelis et al., 2013). Table 1 illustrates this for Germany, Italy and Switzerland, in terms of the incidence of mortgage debt, the indebtedness of households, the size of the rental market and the ownership structure of housing units.

After further describing these differences in the housing market, we discuss their relevance for the transmission of monetary policy.

Column 1 of Table 1 shows that less than half of the German and Swiss households own the home in which they live, implying the lowest owner occupation rates in the OECD. In contrast, in Italy the size of the rental market is much smaller given an owner occupation rate of more than three quarters.[2] The rental market does not only differ in size across the considered countries but also in terms of its ownership structure. Column 2 of Table 1 shows that large real estate investors, i.e., private firms and pension funds, hold almost 40% of the rental housing stock in Switzerland, 10% in Germany and less than 5% in Italy. Publicly owned housing accounts for one third of the rental housing stock in Germany, one fifth in Italy and only one tenth in Switzerland.[3] Columns 3 and 4 of Table 1 illustrate that the incidence and size of household debt also differ widely across the considered countries, and are largest in Switzerland and smallest in Italy.

The extent of household leverage, homeownership and the ownership structure of rental housing matters for the transmission of monetary policy to the housing market in terms of housing tenure choices, rents or house prices.[4] After a shock to the policy rate, households revise their decision to consume housing services by renting or owning the accommodation in which they live. Whether households change their housing tenure after the shock depends on the user cost of owning a home relative to the rental price for housing services. Diaz and Luengo-Prado (2008) show in a life-cycle model with illiquid housing that a change in the mortgage interest rate has a stronger effect on the user cost of owning a house if households expect to be more leveraged when owning the home. We aim to estimate empirically the price and quantity responses in the housing market to demand shocks for owned housing that have been triggered by changes to this user cost resulting from monetary policy.

The degree to which house prices and rents and thus the price-rent ratio respond to monetary policy shocks also depends on the ownership structure of rental housing.[5] If

[2]Thus, the owner occupation rate in Italy is larger than those in the U.S. or the U.K. where about two thirds of households own their first residence. Table 1 displays the owner occupation in the year 2014. During 2000-2014, the owner occupation rate has increased between 3 and 4 percentage points in Germany, Italy and Switzerland.

[3]Moreover, private households own three quarters of the rental housing stock in Italy compared with approximately 50% in Germany and Switzerland. See the notes to Table 1 for the data sources.

[4]A related body of the literature analyzes how the illiquidity of assets, such as housing, matters for the monetary policy transmission to both nondurable and durable consumption. Without sufficient liquidity in the asset portfolio, the marginal propensity to consume out of transitory income shocks increases (Kaplan and Violante, 2014), which is a key determinant of the consumption response to interest rate changes (Auclert, 2019).

[5]Over the time horizon for which we measure the effects of the monetary policy shocks, housing construction has a negligible effect on housing supply. Hence, the elasticity of the housing supply over that horizon is mostly determined by the ownership structure of existing housing units.

	Owner occupation rate	Rental housing owned by private firms (%)	Incidence of mortgage debt	Household debt per GDP
Germany	46	10	49	63
Italy	79	4	15	49
Switzerland	38	38	78	114

Table 1: Heterogeneity in housing markets

Sources: Owner occupation rate: ECB (Statistical Data Warehouse, Dataset *SHI*, Key *SHI.A.DE.TOOT.P*), SHIW, SFO (Federal Population Census, Table *09.03.02.01.01*). Housing ownership: SOEP, SHIW, FSO (ownership type for rental housing, Table *09.03.03.50*). Incidence of mortgage debt: SOEP, SHIW, SHP. Household debt: IMF (Global Debt Database, Private debt, Household debt, all instruments). *Notes:* The first column shows owner occupation rates in 2014 in percent. The second column shows the ownership of rented housing by private firms and pension funds in 2016 in Germany (SOEP), in 2016 in Italy (SHIW), and 2017 in Switzerland (SFO), given data availability. The third column shows the percentage of homeowners with mortgage debt in 2016 for Germany, Italy and Switzerland. The fourth column displays average household debt over GDP during 2000-2016.

rental units are owned by deep-pocket private investors, then housing markets are less segmented such that the supply of these rental units to households willing to buy is more elastic (Greenwald and Guren, 2019). The more segmented housing markets are instead, the stronger is the response of the price-rent ratio relative to the quantity response after a demand shock for owned housing, triggered by an unexpected monetary policy shock that has passed through to the user cost of owning a home.

Thus, public ownership of rental units may affect the transmission of monetary policy to the housing market. Publicly owned rental housing that is not for sale reduces the supply of housing units that potential homeowners can buy. Furthermore, rents of publicly owned units may react less to changes of market interest rates in Germany and Italy than in Switzerland where rents are indexed to a reference mortgage rate.[6]

Given the previous discussion, a key part of the monetary policy transmission to the housing market is the pass-through of monetary policy shocks to mortgage rates. This pass-through is particularly relevant for new mortgagors who are purchasing a home. For existing mortgagors, shocks to the policy rate have a stronger effect on cash flows if they have an adjustable-rate mortgage, can refinance a fixed-rate mortgage or release home equity at a low cost (Calza et al., 2013).

The incidence of mortgage types differs considerably across countries (see Badarinza et al., 2018, ECB, 2009, and the references therein). Typical mortgage contracts in Germany, Italy and Switzerland have different characteristics relative to those in the U.S. and the U.K., which have been analyzed in most of the literature. Most households in the U.K. have adjustable rate mortgage contracts and they can release home equity. In the U.S. most households have fixed-rate mortgages but can refinance their mortgages at lit-

[6] Until 2008, the reference rate was the average mortgage rate recorded by banks at the cantonal level. Since then, there has been a single national reference average rate. Whether rents are indeed adjusted after a change in the mortgage interest rate depends on whether landlords and tenants agree to implement the change.

tle cost (ex post, the bank bears the cost of foregone interest if a household decides to refinance). Therefore, a decrease in the mortgage interest rate reduces the mortgage payments of existing indebted homeowners more in the U.K. and the U.S. than in Germany and Switzerland, where most mortgage contracts have a fixed rate, refinancing is very costly and possibilities for equity release are not common. Italy is an intermediate case because mortgage contracts with fixed or adjustable rate are equally prevalent and costs to refinance mortgages have decreased since 2007, when pre-payment penalities were banned.[7]

Table 39 in the data appendix A.5 shows that the incidence and type of mortgages also differ across Italian regions with different degrees of financial development, whereas the homeownership rate is similar. The incidence of mortgagors, as percentage of owners, is 3.3 percentage points higher in financially developed regions and is 7 percentage points higher if we consider new owners. Furthermore, the incidence of flexible-rate mortgages among mortgagors is 16.6 percentage points higher in financially more developed Italian regions.

Whether it is attractive to become a *new* homeowner depends on whether the pass-through of policy rate shocks decreases the user cost of owning relative to renting housing services. As we show in Section 4, the pass-through of the policy rate shocks to rates of newly originated fixed-rate mortgages implies persistent effects of monetary policy shocks in Germany, Italy and Switzerland. This persistence is qualitatively similar to that in the U.S. (Nakamura and Steinsson, 2018) and the U.K. (Gerko and Rey, 2017).

3 Identification of monetary policy shocks

For Germany and Italy monetary policy is decided by the European Central Bank (ECB). The three key interest rates set by the ECB are, in increasing order of the value of the rates, the rate on the deposit facility, the rate on the main refinancing operations and the rate on the marginal lending facility. For Switzerland, the target rate was the three-month Swiss-Franc Libor during the period we consider, together with the range set by the Swiss National Bank (SNB). We construct a time series of monetary policy shocks for the period 2000 – 2017, given the availability of the other data used in our analysis, the introduction

[7]The percentage of variable-rate mortgages as percentage of new loans is 15% in Germany compared with 47% in Italy (ECB, 2009, Table 2). For Switzerland, Basten and Koch (2015) provide evidence using 12,700 representative mortgage transactions between 2008 and 2013 from the online platform *Comparis*. They show that contracts with rates that are fixed for four years or more accounted for around 75% of all contracts in Switzerland, where contracts with rates that are fixed for ten years accounted for 35% of new contracts and contracts with rates that are fixed for five years accounted for 26%. Only 5% of new mortgage contracts had an adjustable rate. Basten and Koch (2015) further show that changes in house prices mostly affect mortgage volumes through new mortgagors rather than through refinancing activities of existing mortgagors.

of the euro and the targeting of the three-month Swiss-Franc Libor by the SNB during 2000-2019. Because the policy rates of the ECB and SNB co-move with economic conditions,[8] we need to construct a measure of exogenous changes in the interest rate for the empirical analysis.

We identify monetary policy shocks using high-frequency data on the changes in financial-market expectations, which are contained in futures contract prices on interest rates in narrow time windows around the dates of monetary policy announcements. The identification of monetary policy shocks relies on the assumption that changes in the price of futures in these narrow time windows are the result of news contained in the policy announcements and not the result of other events that are systematically related to the monetary policy shocks. For our benchmark estimates we use time windows of one day, between the end of the announcement day and the day before, and we check the robustness for narrower time windows.

As mentioned in the analysis of Wong (2019) for the U.S., one concern may be that policymakers have private information about the state of the economy which is correlated with economic outcomes and thus household decisions. In this case, the measured policy shock consists of the true shock and an error which may be correlated with housing tenure or other economic outcomes. Such an error term likely would not be i.i.d. and thus would introduce some persistence into our series of the monetary policy shock. In columns 1 and 3 of Table 14 in Appendix A.1, we check this issue by regressing the current quarterly shocks against their *past* values, with lags of up to four quarters. We find no evidence of persistence for our constructed series of policy shocks for the euro area and Switzerland, respectively, supporting that our constructed series of policy shocks are true shocks.[9]

The advantage of identifying monetary policy shocks using high-frequency data on market expectations is that one does not need to make further assumptions about policymakers' information set or to impose identifying restrictions, as in the traditional VAR-literature, to disentangle the endogenous and exogenous components of monetary policy. Such assumptions frequently result in shock series for monetary policy shocks that are not easily reconciled with data on financial market expectations (see, for example, the

[8] In particular, monetary policy may respond to housing market conditions. See the discussion in Woodford (2012) on whether central banks should pay attention to the evolution of asset prices and financial stability when making monetary policy decisions, and the empirical evidence in Schularick et al. (2020).

[9] In our analysis, we cumulate shocks for every year. Figure 5 in Appendix A.1 shows the correlograms of the series with shocks cumulated over a year. Even for the cumulated series of the shocks, we do not find significant autocorrelations beyond two quarters, which is comforting because the multicollinearity of the lagged shocks in the regressions is not a concern. In columns 2 and 4 of Table 14 in Appendix A.1, we check whether *future* cumulated shocks can be predicted by past cumulated shocks. We find that past shocks have no predictive power for future shocks in the euro area. This is also, by and large, the case for the Swiss series, with the exception that past shocks with a lag of three years or more are significant at the 10% level. The sample size is smaller in these regressions because of the longer lags.

critique by Rudebusch, 1998).

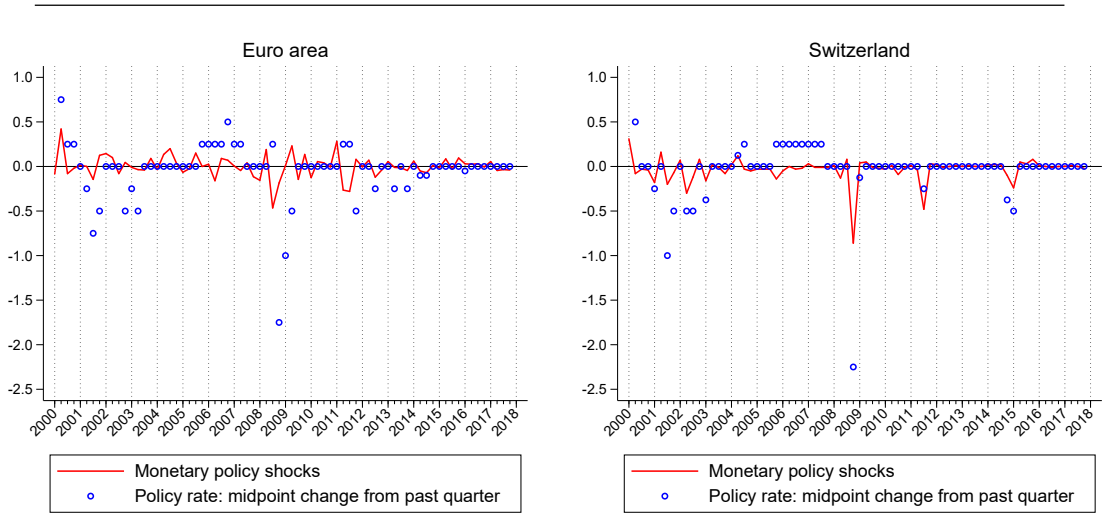
We retrieve market expectations about policy rates by using price data (from *TickData-Market*) of futures contracts on the policy rate or a close counterpart. The midpoint of the policy rates is the rate on the main refinancing operations of the ECB, which is relevant for Germany and Italy, and the three-month Swiss-Franc Libor rate for Switzerland. Whereas futures are traded for the three-month Swiss-Franc Libor, this is not the case for the rate on the main refinancing operations. Therefore, we use futures on the three-month Euribor. The Euribor is highly correlated with the rate on refinancing operations, as shown in Figure 6 in Appendix A.1.[10]

We use the futures contracts on the three-month Euribor, not the overnight interest swaps as in Altavilla et al. (2019), as a measure of the interest rate shocks in the euro area because the adjustable-rate mortgages in the euro area use the three-month Euribor as the reference rate. This is analogous to the three-month Swiss-Franc Libor for Switzerland. Using the three-months Euribor also has the advantage that we can use data from 2000 onwards. This would not be possible if we used overnight interest swaps because, as mentioned in Altavilla et al. (2019), the data for the overnight interest swaps are very noisy until 2002.[11]

Figure 1 plots our measure of the monetary policy shock constructed from the unexpected futures price changes together with the actual changes in the midpoint policy rate. We cumulate the shocks, which we obtain by computing the rate changes in the narrow time window around each policy announcement, and the corresponding midpoint policy rate changes for all announcements within a quarter. As can be seen in Figure 1, changes in the policy rate are partly anticipated. For example, only a small part of the large decrease in the policy rate in 2008 has been unexpected. Instead, on other announcement dates, markets expected a reduction in the policy rate whereas the central bank kept the

[10]Given that future contracts often mature around the announcement dates, we use futures contracts that deliver a specified rate in the quarter following the monetary policy announcement. These contracts mature after the announcement dates, and we observe the price changes for these contracts around the announcement dates. We do not need to adjust the implied rates of the futures contracts for the number of days until expiry. In Gürkaynak et al. (2005), Nakamura and Steinsson (2018) or Wong (2019) this is necessary because they use contracts of federal funds futures in the U.S. that have a payout based on the average effective rate in a given month.

[11]The overnight interest swaps (OIS) use the euro overnight index average (EONIA) as the reference rate. For the same three-month maturity, the monetary policy shocks constructed based on the OIS and the Euribor futures are highly correlated with a correlation coefficient of 0.59 in our sample period. The correlation is not perfect because the series differed in periods of high financial distress, such as the financial crisis and the sovereign debt crisis in the euro area. In these crises, the spread between the EONIA and the Euribor captures the counterparty credit risk, given that lending overnight based on the EONIA is rolled over daily until maturity in the three-month period whereas lending from one counterparty based on the three-month Euribor is not and thus has higher counterparty credit risk. Hence, for these crises episodes, changes in the futures of the three-month Euribor also capture changes in interbank risk premia, which are relevant for mortgage interest rates. Because we want to capture this effect, we use the Euribor futures for our analysis of the transmission of monetary policy shocks to the housing market.



Sources: Short-term rates from ECB (Statistical Data Warehouse, Table *ECB/Eurosystem policy and exchange rates*, Subtable "Official interest rates") and SNB (Data Portal, Table *Official interest rates*). Futures contracts' prices from *TickDataMarket*. *Notes:* Quarterly data. The series of shocks is constructed using data on futures contracts for the 3-month Swiss-Franc Libor and the Euribor. Both the shocks and the midpoint changes are cumulated quarterly.

Figure 1: Monetary policy shocks and midpoint policy rate changes (%)

rate unchanged. This resulted in an unexpected shock reflecting that the policy rate remained higher than expected.

The average of the shocks is approximately zero in the sample period for the ECB and −3 basis points for the SNB. The standard deviation of the shocks is 7 basis points for the ECB and 10 basis points for the SNB,[12] similar to the 9 basis points reported in Wong (2019) for the Federal Reserve during the 1990 – 2007 period. Given that some shocks in the sample are much larger than others, we check the robustness of our results in Appendix A.2.3 if we exclude the years 2007 and 2008 and thus the large policy rate shock during the financial crisis. We also check the robustness in Appendix A.2.4 if we exclude periods with a negative interest rate policy (NIRP), or if we use shocks to long-term yields instead of the policy rate given that long-term yields are positive in the sample period.

As previously mentioned, we further check the robustness by constructing the shocks using narrower time windows to measure the price changes in the future contracts based on data at a minute frequency as provided by *TickDataMarket*. For Switzerland, we con-

[12]The difference in the standard deviation may be related to the different frequency of the regular announcements. The ECB announces rate decisions every six weeks. The SNB announcements have a lower frequency of three months. Tables 12 and 13 in Appendix A.1 show that the mean and the standard deviation of the shocks increase as we cumulate them within a quarter or year, quantitatively similar to results reported by Wong (2019), Table 1, for the rate shocks of the Federal Reserve in the U.S.

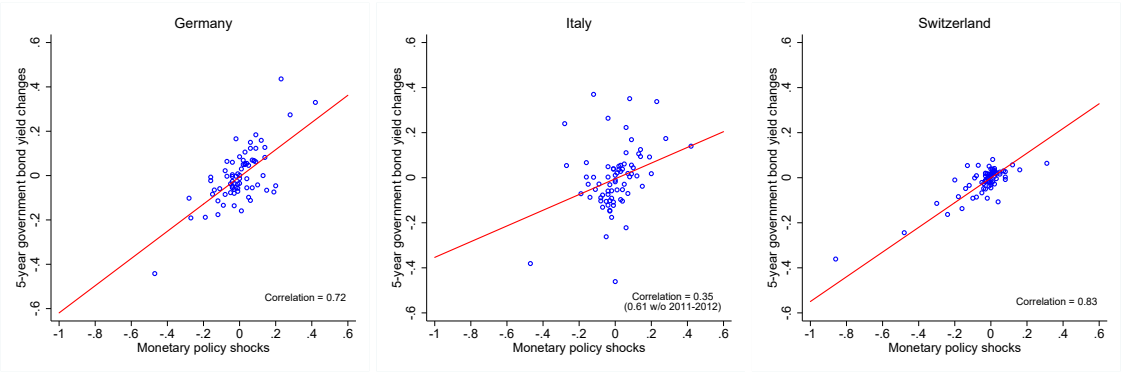
sider a very narrow time window of only 30 minutes around the announcement, starting 10 minutes before the announcement. This replicates the identification strategy of Gertler and Karadi (2015) and Nakamura and Steinsson (2018) for the U.S. Considering such a narrow time window is sensible for Switzerland because press conferences of the SNB after announcements are only held occasionally and, generally, announcements are made available to the public only through the SNB website. Instead, press conferences are common at the ECB. Thus, we also consider a larger time window, which accounts for the fact that monetary policy decisions are communicated slightly differently by the ECB and SNB than the Federal Reserve. As in Corsetti et al. (2018), our measure of shocks is broad, including the various communication channels through which monetary policy announcements affect the economy (Altavilla et al., 2019)

The ECB typically makes an initial policy announcement at 13:45 (CET), in which the policy rate decision is briefly stated. In a subsequent press conference at 14:30 (CET), the decision is explained further. Therefore, we also construct the shocks with a time window from 13:00 to 19:00, as in Corsetti et al. (2018). The SNB announcements are first released on its website, which is directly followed by a press conference only for the quarterly meetings in June and December. The precise time of day of the announcement varies but is known in advance, and the press conference lasts for approximately one hour. The majority of the statements in our sample started between 09:30 and 14:00 (CET).[13] Given the similar structure of the SNB announcements, for the instances in which announcements are followed by a press conference, we also consider a time window of six hours around the announcement time as for the ECB. The results for the responses of housing tenure and rents, using these alternative time windows to measure the monetary policy shocks, are discussed in Sections 6 and 7 and reported in Appendices A.2 and A.3.

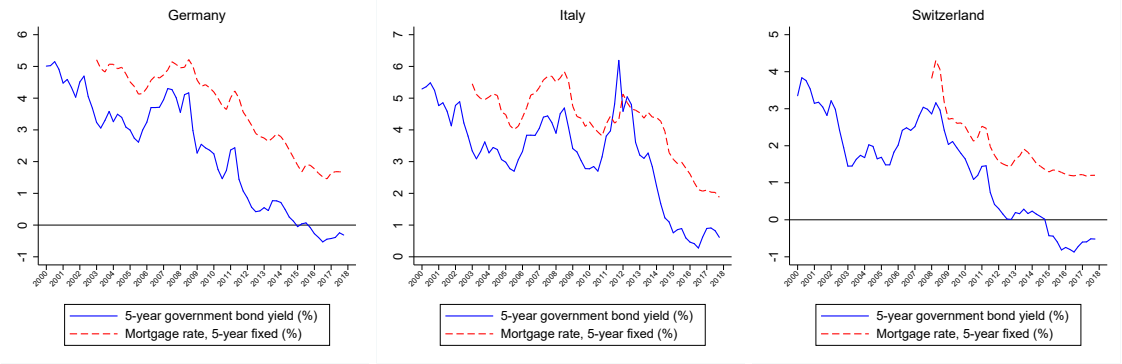
4 Pass-through to market interest rates

Key for the monetary policy transmission to the housing market is the pass-through of the monetary policy shocks to the mortgage interest rates which affect the user cost of owning a home. The results presented in this section indicate that the shocks indeed have a persistent effect on interest rates and thus pass through to long-term interest rates such as mortgage rates in Germany, Italy and Switzerland. We find that the pass-through to five-year fixed-rate mortgage rates is twice as large in Switzerland than in Germany and Italy.

[13] The initial SNB statements started between 08:50 and 17:45 (CET) in our sample. All of the June and December meetings started in the morning. On 06.09.2011, 18.12.2014 and 15.01.2015 extraordinary announcements were followed by a press conference.



(a) Monetary policy shocks and long-term bond yield changes on announcement dates (%)



(b) Long-term bond yields and rates for fixed-rate mortgages (%)

Sources: Rates of five-year fixed-rate mortgages from ECB (Germany *MIR.M.DE.B.A2C.O.R.A.2250.EUR.N*, Italy *MIR.M.IT.B.A2C.O.R.A.2250.EUR.N*) and SNB (*EPB@SNB.zikrepro{M,50}*). Five-year government bond yields from Thomson Reuters (RIC *DEMYT*, *ITMYT* and *CHMYT*, where *MYT* denotes maturity). *Notes:* Panel (a) uses daily changes on announcement dates between 2000Q1 and 2017Q4. Panel (b) displays quarter values for the mortgage rates, and quarterly averaged bond yields.

Figure 2: Monetary policy shocks and long-term interest rates

Our analysis of the pass-through proceeds in the following steps. We first establish that policy rate shocks affect long-term bond yields, on which we have data for the narrow time window around the policy announcement dates. We illustrate the persistence of the pass-through by considering yields with different maturity and we show that the yields of long-term bonds co-move with mortgage interest rates. We then estimate the pass-through of the policy shocks to rates of five-year fixed-rate mortgages, which are available at a monthly frequency. We also show that the policy rate shocks affect the spread between mortgage rates across Italian regions, at a quarterly frequency given the data availability.

4.1 Pass-through to long-term yields

Panel (a) of Figure 2 shows that our measure of monetary policy shocks for the ECB and SNB, respectively, is highly correlated with changes in the yields of five-year government bonds which are available in the same time window around the announcement dates. Panel (b) of Figure 2 illustrates that fixed-rate mortgage rates co-move with long-term bond yields. Fixed-rate mortgage rates are available for part of the sample period and not at the high frequency around the announcement dates.

Table 2 provides quantitative evidence on the pass-through of the monetary policy shocks to yields with different maturities. Each number reported in the table corresponds to a coefficient estimate obtained by regressing the interest rate of the respective financial instrument on a constant and the monetary policy shock. A coefficient value of 1 corresponds to a full pass-through of the shock (i.e., a shock of 25 basis points translates to a change of 25 basis points in the interest rate of the respective financial instrument).

The estimated regression coefficients reveal that the shocks have persistent effects on interest rates in both countries. At the top of the table, we report the effect on the implied short-term interest rate of future contracts up to 21 months in the future. The effect on these expected short-term rates is easier to interpret than the effect on bonds with longer maturities, reported below in the same table: the effect on the rates of the long-term bonds depends on the average of the effect on short-term rates over the life of the bond and may also be affected by changes in the risk or term premium.[14] The size of the coefficients at

[14]Nakamura and Steinsson (2018) present evidence that indicates that changes in risk premia are not the main drivers in the transmission of monetary policy shocks, identified by high-frequency variation, on long-term interest rates. The empirical analysis using daily data on yields for Switzerland by Söderlind (2010) suggests that an increase in expected short-term interest rates may confirm the credibility of price stability and thus lead to a *de*crease in long-term rates via a reduced term premium. Without such an effect, the effect of changes in short-term rates on long-term rates would be even larger. For the euro area, changes in risk premia in financial crises and sovereign debt crises explain some of the differences in the pass-through to German compared with Italian government bonds which we observe in Table 2. If we exclude the years 2008/9 of the financial crisis and the years 2011/12 of the euro-area debt crisis, then the regression coefficients for Italy are much more similar to the coefficients for Germany, taking the values of 0.635, 0.530, 0.581, and 0.524 for the government bonds with maturities of three, four, five and six years,

Table 2: Persistent effects of monetary policy shocks

	Euro area			Switzerland
6M Futures' implied rate	0.803***			0.920***
	(0.059)			(0.037)
9M Futures' implied rate	0.853***			0.855***
	(0.058)			(0.047)
12M Futures' implied rate	0.859***			0.786***
	(0.058)			(0.059)
15M Futures' implied rate	0.818***			0.762***
	(0.057)			(0.067)
18M Futures' implied rate	0.779***			0.727***
	(0.057)			(0.076)
21M Futures' implied rate	0.737***			0.709***
	(0.055)			(0.084)
	Germany		Italy	Switzerland
3Y Government bond yield	0.638***		0.528***	0.496***
	(0.062)		(0.087)	(0.057)
4Y Government bond yield	0.609***		0.468***	0.451***
	(0.056)		(0.090)	(0.044)
5Y Government bond yield	0.629***		0.438***	0.412***
	(0.057)		(0.088)	(0.043)
6Y Government bond yield	0.586***		0.406***	0.344***
	(0.055)		(0.074)	(0.051)
	Nominal	*Real*	*Inflation*	
5Y Government bond yield†	0.813***	0.318***	0.495***	
	(0.067)	(0.063)	(0.080)	

Sources: Futures' implied rates from Thomson Reuters (RIC *FEIMYD* and *FESMYD*, where *MYD* denotes month, year and decade). Bond yields from Thomson Reuters (RIC *DEMYT*, *ITMYT* and *CHMYT*, where *MYT* denotes maturity, and ISDN *DE0001030526* for the *Bobl* real bond). *Notes:* Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. †Estimates for the transmission to nominal rates, real rates, and break-even inflation using the 90 monetary policy announcements since the inflation-indexed Bobl bond has been issued in Germany in 2009. Standard errors are in brackets. The table reports the coefficients of separate regressions for each financial instrument against the monetary policy shocks series and a constant for Germany, Italy and Switzerland, respectively. The series are based on daily changes in the rates on the announcement dates during 2000Q1-2017Q4. The number of announcements in the sample period is 87 for Switzerland and 229 for the euro area.

short maturities as reported in Table 2, and the persistence of the effect of monetary policy shocks on nominal rates, are similar to the estimates for the U.S. reported in Table 1 of Nakamura and Steinsson (2018). One difference is that the pass-through monotonically decreases for instruments in Switzerland with longer maturity and the pass-through is strongest in the euro area at a maturity of one year. For the U.S., Nakamura and Steinsson (2018) find that the pass-through is strongest at a maturity of two years.

For Germany, we provide evidence for the effect of monetary policy shocks on real rates for a shorter sample period. Inflation-indexed *Bobl* bonds have been issued only since 2009 and we have a sample of 90 monetary policy announcements since then. We use the available data on five-year nominal and real government bonds because no indexed bonds with shorter maturities are issued. We find that more than one third (39%) of the response of the nominal rate to the monetary policy shock can be attributed to the change in the real rate. The effect on break-even inflation accounts for the remaining response, where break-even inflation is computed as the difference between the nominal and real yields. Compared with the empirical evidence of Nakamura and Steinsson (2018) for the U.S., we find a stronger positive effect of monetary policy shocks on break-even inflation in Germany. Our results suggest that, on impact in our sample period, markets have revised their inflation expectations upward after an unexpected positive change in the policy rate.

4.2 Pass-through to mortgage interest rates

We estimate the pass-through to mortgage interest rates using aggregate data on mortgage rates available at a monthly frequency.[15] We estimate the pass-through to rates of five-year fixed-rate mortgages because this is a representative mortgage type in Germany and Switzerland, and relevant for Italy as well (see Section 2). The pass-through for adjustable-rate mortgages is more mechanical because the three-month Euribor and Swiss-Franc Libor are the respective reference rates in these adjustable-rate contracts.

Table 3 shows that the pass-through of the policy rate shocks to the rates of five-year fixed-rate mortgages is twice as large in Switzerland than in Germany and Italy. The results in the top part of Table 3 imply that an unexpected 25 bp cut in the policy rate reduces the mortgage rate by 22 bp in Switzerland within two months, and only by 10–12 bp in Germany and Italy. Furthermore, the pass-through in Switzerland occurs immediately, i.e., in the same month as the policy rate shock. Most of the pass-through in Germany and Italy occurs a month later, following the policy rate shock. Comparing the top and bot-

respectively. Thus, we perform robustness checks in our analysis in which we omit the crises episodes.

[15]The information on mortgage interest rates in the household-level data for Italy is available only at a biannual frequency. The information on mortgage payments, available in the household-level data for Germany and Switzerland, are available at an annual frequency. A disadvantage is that these data contain both quantity and price effects resulting from interest rate changes.

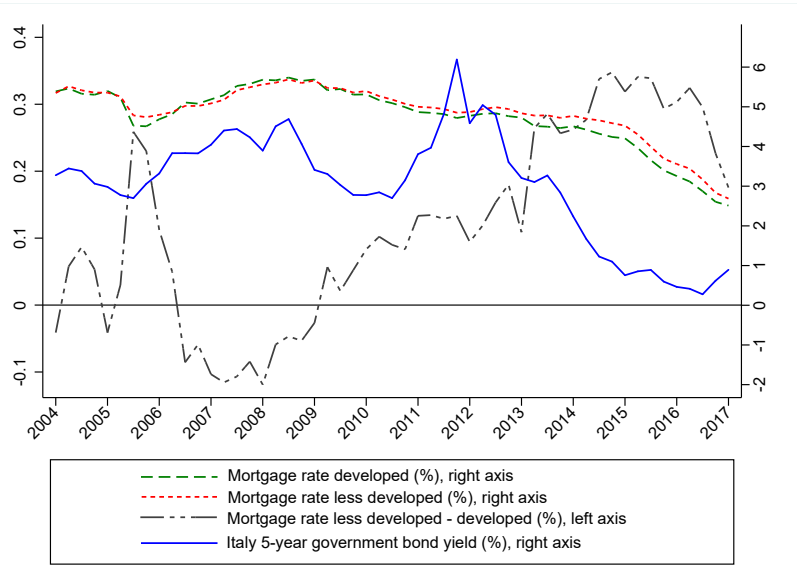
Table 3: Pass-through of policy rate shocks to five-year fixed-rate mortgage rates

	Germany	Italy	Switzerland
Monetary policy shocks, sum M(0)	−0.012	−0.155	0.793*** †
Monetary policy shocks, sum M(-1)	0.295***	0.360**	0.014
Monetary policy shocks, sum M(-2)	0.210**	0.210	0.069
Cum. effect (in pp) of 25 bp cut	−0.123***	−0.104	−0.219***
Monetary policy shocks, sum M(0)	−0.021	−0.159	0.795*** †
Monetary policy shocks, sum M(-1)	0.281***	0.386***	0.017
Monetary policy shocks, sum M(-2)	0.231**	0.213	0.067
Monetary policy shocks, sum M(-3)	0.054	0.108	0.049
Cum. effect (in pp) of 25 bp cut	−0.137***	−0.137	−0.232***

Sources: Rates of five-year fixed-rate mortgages from the ECB (Germany *MIR.M.DE.B.A2C.O.R.A.2250.EUR.N*, Italy *MIR.M.IT.B.A2C.O.R.A.2250.EUR.N*) and the SNB (*EPB@SNB.zikrepro{M,50}*). *Notes:* Regression of monthly mortgage-rate changes on policy rate shocks cumulated by month. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The series is based on the monthly changes in the rates available for the 2008M1-2017M12 period in Switzerland and the 2003M1-2017M12 period in the euro area. The cumulative effect over three years of a -25 bp shock is computed by multiplying the sum of the coefficients by -0.25.

† Regular policy announcements at the SNB occur once a quarter. For the months without an announcement the value of the shock is zero.

tom part of the table shows that the pass-through occurs within two months in all three countries. Adding a further lag of the policy rate shock implies only minor changes to the coefficient estimates. Table 15 in Appendix A.1 shows that the pass-through to the mortgage rate increases from 10 bp to 18 bp in Italy, and remains very similar for Germany and Switzerland, if we only consider policy rate shocks that are positively correlated with long-term (government) bond yields. This finding suggests that the pass-through in Italy to mortgage rates was weaker during the euro-area debt crisis, in which the pass-through of policy rate shocks to government bond yields was different because of changes in risk premia. This is illustrated in Figure 3 which shows that fixed-rate mortgage rates co-move positively with the rates of long-term government bonds in both financially more and less developed Italian regions, but for the years 2010-2012 of the sovereign debt crisis in the euro area.



Sources: Mortgage rates from Banca d'Italia (Statistical Database, Table *Lending rates applied to loans for house purchase (stock) - by initial period of rate fixation, customer region and total credit granted (size classes)*, >= 125,000 euros, over 1 year fixation, Reference *TDB30890*). Five-year government bond yields from Thomson Reuters (RIC *ITMYT*, where *MYT* denotes maturity). *Notes:* The mortgage rate in less developed regions is the average quarterly mortgage rate in Sardinia, Tuscany, Abruzzo and Molise, Basilicata, Sicily, Apulia, Lazio, Campania and Calabria. The mortgage rate in developed regions is the average quarterly mortgage rate in Marche, Liguria, Emilia-Romagna, Veneto, Piedmont, Trentino-Alto Adige, Lombardy, Friuli-Venezia Giulia and Umbria.

Figure 3: Long-term interest rates and regional mortgage rates in Italy

Figure 3 further shows that the aggregate mortgage rate in Italy hides sizable regional heterogeneity. Among the three countries considered, these regional differences are specific to Italy. We exploit them for identification in Section 8 when we estimate the trans-

mission of policy rate shocks to the housing market across Italian regions. We categorize the Italian regions as financially more or less developed, which is highly correlated with Northern and Southern Italian regions in line with previous research by Guiso et al. (2004) as further documented in Table 37 of the data appendix A.5.

Table 4: Effect of bond yield changes and monetary policy shocks on mortgage-rate spread across Italian regions

	Mortgage rate less developed - developed		
Q-o-q 5y Italian bond yield change, sum Q(-1;-4)	-0.051***		
Q-o-q 5y Italian bond yield change, sum Q(-5;-8)	-0.050**		
Q-o-q 5y Italian bond yield change, sum Q(-9;-12)	-0.024		
Monetary policy shock, sum Q(-1;-4)		-0.007	
Monetary policy shock, sum Q(-5;-8)		0.017	
Monetary policy shock, sum Q(-9;-12)		-0.044	
Effective monetary policy shock, sum Q(-1;-4)			-0.186**
Effective monetary policy shock, sum Q(-5;-8)			-0.152*
Effective monetary policy shock, sum Q(-9;-12)			-0.171**
Year dummies	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes
Observations	53	53	53
Adjusted R^2	0.85	0.82	0.84
Cum. effect (in pp) of 25 bp cut	0.03**	0.01	0.13**

Sources: Regional mortgage rates from Banca d'Italia (Statistical Database, Table *Lending rates applied to loans for house purchase (stock) - by initial period of rate fixation, customer region and total credit granted (size classes)*, >= 125,000 euros, over 1 year fixation, Reference *TDB30890*). Bond yields from Thomson Reuters (RIC *ITMYT*, where *MYT* denotes maturity). *Notes:* Regression of difference between average mortgage rate difference between less developed and developed Italian regions against bond yield changes and monetary policy shocks for 53 observations between 2004Q1 and 2017Q1. The regression using effective monetary policy shocks only uses those monetary policy shocks that have the same sign as the Italian five year government bond yield change on announcement dates. The mortgage rate in less developed regions is the average quarterly mortgage rate in Sardinia, Tuscany, Abruzzo and Molise, Basilicata, Sicily, Apulia, Lazio, Campania and Calabria. The mortgage rate in developed regions is the average quarterly mortgage rate in Marche, Liguria, Emilia-Romagna, Veneto, Piedmont, Trentino-Alto Adige, Lombardy, Friuli-Venezia Giulia and Umbria. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

Figure 3 shows that the spread between the mortgage rate in the less developed and developed regions varies considerably in the sample period, is larger than 30 bp in some sample years, and is negatively correlated with the level of the long-term interest rate. The regression results in Table 4 confirm these findings, based on data at a quarterly frequency. The results in column 1 show that the spread of the mortgage rate across Italian regions with different financial development is negatively correlated with changes

in long-term bond yields. The results in columns 2 and 3 show that the pass-through of the policy rate shocks to the spread is only economically and statistically significant if we consider policy rate shocks that are positively correlated with long-term yields (column 3). Once we implicitly exclude the euro-area debt crisis episode, in which the policy rate shocks have been less effective in passing through to long-term yields, an unexpected 25 bp cut in the policy rate increases the spread by decreasing the mortgage rate by 13 bp more in financially developed Italian regions.

5 Household data on housing markets

We use household-level data to analyze the transmission of monetary policy to the housing market. Given that we have shown in the previous section that policy rate shocks pass through to mortgage interest rates and thus affect the user costs of households, the household-level data allow us to investigate in detail the gross flows across housing tenure states, the pass-through to rents and house prices, and the heterogeneity of this pass-through across households with different ages, incomes, and net worth. Because we have information on house prices only from the Italian and German household-level data, we provide evidence for Switzerland on the pass-through to the price-rent ratio based on aggregate data.[16]

We use microdata from the German Socioeconomic Panel (SOEP), the Italian Survey of Household Income and Wealth (SHIW), and the Swiss Household Panel (SHP). For Switzerland we complement the panel data with repeated cross-sectional data on rents from the Swiss household budget survey (HABE). For Germany and Italy, information on rents is available in the SOEP and SHIW. Further recent descriptions of the data are provided by Goebel et al. (2019) for the SOEP, the Bank of Italy for the SHIW,[17] Voorpostel et al. (2017) for the SHP and BFS (2013) for the HABE.

Because households in the annual surveys for Germany and Switzerland are interviewed across all quarters and the sample size is sufficiently large, we can use variation across quarters during the period $2000Q1 - 2016Q4$. Because of the lagged independent variables in the estimations, the sample for the estimation starts in $2003Q1$ for both countries. The sample size is $138,682$ for Germany, and $45,816$ and $22,918$, respectively, for the samples obtained from the SHP and HABE datasets in Switzerland. The unit of observation is a household interviewed in a quarter of a given year. For Italy the sample size is $27,896$ and the biannual survey frequency requires that we exploit variation across years

[16] For Germany we approximate the house value using information on mortgage payments, as explained in data appendix A.5.

[17] See https://www.bancaditalia.it/statistiche/tematiche/indagini-famiglie-imprese/bilanci-famiglie/index.html .

during the same sample period. The Italian data have the advantage that we can exploit in our analysis the regional heterogeneity in the pass-through to mortgage rates and the housing market. We thus obtain further insights by using these regional differences to identify the transmission of monetary policy to the housing market. Before we move on to the analysis of the transmission, we provide descriptive evidence on some key characteristics of the sample that we use for our analysis. We refer to the data appendix A.5 for further details on the data sets and the sample construction.

Table 5: Homeownership and mortgage debt by age group

Ownership rate (%)	**Germany**	**Italy**	**Switzerland**
Aged 25-44	36.8	62.0	38.5
Aged 45-64	58.2	79.6	61.8
Aged 65-84	60.0	84.6	58.7
Incidence of mortgagors (as % owners)	**Germany**	**Italy**	**Switzerland**
Aged 25-44	78.5	36.5	81.9
Aged 45-64	53.9	20.1	80.9
Aged 65-84	16.4	4.9	67.4

Sources: SOEP (Germany), SHIW (Italy), SHP (Switzerland). *Notes:* Given the data availability, the incidence of mortgagors covers the 2002-2016 period for Germany, 2010-2016 for Italy, and 2014-2016 for Switzerland. See Appendix A.5 for further details on the construction of the variables and the sample.

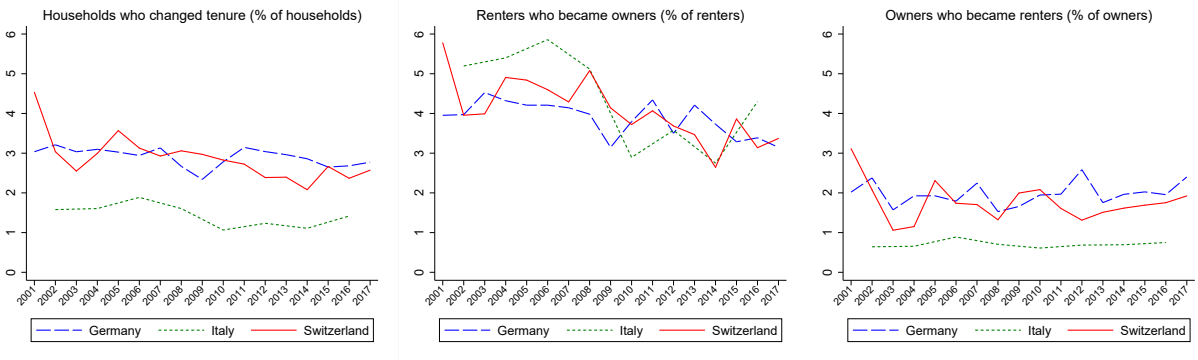
Table 5 displays in the top panel the familiar age profile of homeownership (of the main residence) in Germany, Italy and Switzerland. As mentioned in Section 2, the homeownership rates in Germany and Switzerland are lower than in Italy.[18] Table 5 shows that this is true at all ages and that the ownership rate increases in all countries until retirement. In Switzerland, the ownership rate falls slightly for retired households which relates to the stronger response of the flow from owning to renting to policy rate shocks that we report for Swiss households in the next Section 6.

The bottom panel of Table 5 shows that the incidence of mortgage debt is lower in Italy than in Germany and Switzerland at all ages.[19] During retirement the incidence of mortgage debt is much larger in Switzerland than in Germany and Italy where most

[18]The averages of the owner occupation rate reported in Table 1 do not match exactly the averages across age groups based on the household-level data reported in Table 5 because they are based on a different data source and period.

[19]This pattern is robust if we restrict the sample to new owners, i.e., renters who became owners between the last and the current survey wave. The sizes of the subsamples are much smaller then, between 27 and 128 for the age groups shown in Table 5.

households amortize their mortgage until retirement and then own their home outright. This different amortization behavior in Switzerland is related to different tax incentives for amortization as further analyzed in Koeniger et al. (2021).



Sources: SOEP (Germany), SHIW (Italy), SHP (Switzerland). *Notes:* Annual average flows. For Italy, biannual flows are annualized. Appendix A.6 contains detailed information about how the flows are annualized.

Figure 4: Housing tenure flows over time

The age profiles of the homeownership rates in the top panel of Table 5 suggest that households change housing tenure status. Figure 4 provides explicit information on the transition rates. The left plot displays the percentage of households that have changed housing tenure between the current and previous survey wave. Figure 4 also provides information on the separate flows, from renting to owning and vice versa. The middle plot shows the renters who have become owners (as a percentage of the sample of renters), and the right plot shows the owners who have become renters (as a percentage of owners).

The plots in Figure 4 show that twice as many households change housing tenure per year in Germany and Switzerland than in Italy. On average around 4% of renters per year become homeowners in all three considered countries.[20] The percentage of owners that become renters per year is lower on average, about 2% in Germany and Switzerland. In Italy, homeownership seems more like an absorbing state, given that less than 1% of owners become renters. We exploit the variation in the flows between different types of housing tenure, across quarters and years, to identify the effect of the monetary policy shocks on changes in housing tenure.

Table 6 provides summary statistics for the different housing tenure groups in Germany, Italy and Switzerland. As noted by Andrews and Sánchez (2011a,b), the marginal

[20]The transition rates are annualized for Italy given the biannual frequency of the survey, as explained further in Appendix A.6. When comparing the transition rates from rental to owning across countries, one has to consider that fewer households rent in Italy than in Germany and Switzerland. The transition rates in the considered countries are approximately half of those in the U.S. reported by Ma and Zubairy (2021), Figure 4, once the rates they report are annualized to make them comparable.

Table 6: Summary statistics for housing-tenure groups in Germany, Italy and Switzerland

Germany

	Renters		**Owners**	
	Remained renter	Became owner	Remained owner	Became renter
Observations	64,782	2,649	69,887	1,364
Age (household head)	49.2	46.2	55.5	55.5
Household size (persons)	2.34	2.8	2.7	2.4
In a couple (%)	57.0	78.1	79.8	60.5
Married (%)	44.6	62.5	75.0	51.0
Working (%)	64.6	74.4	63.2	57.8
Gender (% male)	50.41	54.7	65.6	51.8
Domestic citizenship (%)	90.6	92.8	96.5	95.2
Gross household income (2010 EUR, annual)	26,969	46,447	45,134	27,714
Net worth (2010 EUR)	15,974	69,201	120,000	49,788

Italy

	Renters		**Owners**	
	Remained renter	Became owner	Remained owner	Became renter
Observations	5,203	474	21,905	314
Age (household head)	55.8	54.2	60.3	56.7
Household size (persons)	2.5	2.5	2.6	2.0
In a couple (%)	57.4	58.4	70.9	39.2
Married (%)	56.5	56.5	70.3	37.9
Working (%)	45.1	52.3	39.2	48.1
Gender (% male)	52.6	57.8	60.8	51.9
Birth region domestic (%)	87.3	94.3	98.1	93.9
Net household income (2010 EUR, annual)	16,935	25,903	32,151	16,335
Net worth (2010 EUR)	4,660	157,789	230,454	5,516

Switzerland

	Renters		**Owners**	
	Remained renter	Became owner	Remained owner	Became renter
Observations	20,219	820	24,369	408
Age (household head)	50.6	45.2	55.9	55.2
Household size (persons)	2.2	2.8	2.8	2.1
In a couple (%)	53.5	78.0	79.9	52.7
Married (%)	41.8	61.5	75.4	43.4
Working (%)	68.9	80.1	65.9	62.7
Gender (% male)	36.8	37.3	39.7	38.2
Domestic citizenship (%)	88.1	90.0	93.7	95.6
Gross household income (2010 CHF, annual)	93,500	127,259	121,704	97,451

Sources: SOEP (Germany), SHIW (Italy), SHP (Switzerland). *Notes:* Averages for households interviewed between 2002 and 2016. Medians for income and net worth. Changes in tenure refer to changes since the last survey. In 2007Q4, a euro was worth 1.45 US-$ and a Swiss Franc was worth 0.87 US-$. Real incomes and net worth are deflated by the national CPI. The datasets do not contain net worth information for Switzerland, and net instead of gross income for Italy. See Appendix A.5 for further details on the construction of the variables and the sample.

home buyers and sellers in Germany, Italy and Switzerland may be different because of differences in tax incentives and regulation associated with differences in house prices (see also the references therein). To shed light on the characteristics of the households that change housing tenure status, we distinguish renters that have remained renters (since the last survey) from renters that have become homeowners, and we distinguish homeowners that have remained owners from those that have become renters. Table 6 shows that, as one would expect, renters that have become homeowners tend to be younger than those who have remained renters. They have higher incomes, are more likely to work, and have higher net worth (in Germany and Italy, for which data on net worth are available). In Germany and Switzerland, the size of households that have become homeowners is larger and these households are more likely to be composed of married individuals or those living as a couple. The transition from homeownership to rental occurs at later ages, on average previous to retirement. Table 6 shows that owners that become renters have relatively less income and lower net worth (in Germany and Italy, for which data on net worth are available). They are less likely to be married or to live as a couple, implying smaller household sizes.

Across countries, renters that become owners are older in Italy than in Germany and Switzerland which may be related to household formation in Italy occuring later in the life cycle. Moreover, the differences in net-worth positions associated with changes of housing tenure are larger in Italy than in Germany. To understand this further, we inspect the net-worth position of households in Italy in the survey wave previous to the change of their housing tenure. We find that the median net worth of renters who have become owners is 7,505 euro, which is only somewhat larger before the transition than the net worth of households that remained renters. Moreover, the median net worth of 160,539 euro held by owners, before they become renters in the subsequent survey wave, has the same order of magnitude as the net worth of households that have remained owners. The large amount of additional wealth that renters report when they become owners, and the much smaller amount of wealth which owners report after they become renters, suggest that transfers across households, possibly across generations, are associated with housing tenure transitions in Italy. This evidence is in line with the much lower incidence of mortgages in Italy that we have reported in Table 5. Beyond these differences, the characteristics of the respective subpopulations appear quite similar across the three considered countries. Table 38 in Appendix A.5 shows that this also applies to Italian regions with different financial development.

The patterns in the characteristics of the marginal populations that change housing tenure status suggest that the pass-through of policy shocks to housing tenure transitions may be heterogeneous, for example across groups with different ages, incomes, or net

worth. In our analysis, we thus allow for a heterogeneous pass-through in some specifications.

6 The response of housing tenure

In this section we estimate the effect of monetary policy shocks on housing tenure in Germany, Italy and Switzerland. Because the shocks may induce home purchases or sales, we estimate the effect on both the transition from being a renter to becoming a homeowner and vice versa. Homeownership refers to owner occupation of the primary residence in the data sets and does not include ownership of second homes.

We find that a monetary policy shock triggers adjustments in the housing market: some renters become homeowners and, simultaneously, some homeowners become renters. The net effect on owner occupation is positive for an accommodative shock, suggesting that the positive demand effect resulting from such a shock does not only imply higher house prices. We now present our findings in further detail.

We exploit variation at a quarterly frequency for Germany and Switzerland because we have information on the interview date of households. For Italy we use the annual variation in the shocks and biannual transitions given the lower survey frequency. We discuss the resulting differences in the subsequent regression specifications. The reported cumulated effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions, as explained further in Appendix A.6.

Given that households in the German and Swiss panel data are interviewed at an annual frequency, we pool all of the observations on renters to estimate the probability of becoming a homeowner in each quarter and year, and we pool all of the observations on homeowners to estimate the probability of becoming a renter. Households who change housing tenure more than once are captured at each change. Age controls in the regression account for differences in the transition probabilities across age groups.

We use the panel dimension of the surveys to construct a dummy variable for changes in housing tenure during the last year. For household i from region r interviewed in quarter q and year t we define

$$\text{Change}_{irqt} = \begin{cases} 1 & \text{if the housing tenure changed,} \\ 0 & \text{otherwise.} \end{cases}$$

We estimate a linear probability model and provide robustness results for non-linear

probit and logit specifications in Appendix A.2.7. The regression specification is

$$\text{Change}_{irqt} = \alpha + \beta' \mathbf{z}_{qt} + \gamma' \mathbf{x}_{irqt} + D_r + D_q + D_t + \varepsilon_{irqt},$$

where Change_{irqt} is the binary variable previously described, and the vector $\mathbf{z}_{qt}$ denotes the monetary policy shocks in the last three years, cumulated over quarters separately for each of the years.[21] The vector $\mathbf{x}_{irqt}$ contains a set of control variables, which vary at the household level.[22] In all of the regression specifications we control for common effects by quarter D_q and year D_t, and thus control for common trends and seasonal effects. In some specifications we also control for common effects by region D_r, or we allow for heterogeneous effects across population groups with different ages, incomes, and wealth. The identification of these effects exploits the cross-sectional variation in the household data.

The estimation of our specification is straightforward given that the monetary policy shocks have been constructed to be exogenous. The year-quarter variation identifies the effect of the monetary policy shocks in our regressions for Germany and Switzerland. In the specifications for Italy, identification is based on the annual deviations from the trend, and on the region-year variation for the specifications presented in Section 8. To preserve degrees of freedom, we estimate a parsimonious specification. We cumulate shocks per year and allow for lagged effects of shocks up to three years. In Appendix A.2.5 we show that including additional lags of the shocks amplifies the benchmark results for the transitions from renting to owning that we subsequently present, at the cost of less degrees of freedom, such that the main specification provides conservative estimates.[23]

Table 7 summarizes the results for the effect of monetary policy shocks on housing tenure in Germany, Italy and Switzerland. In the benchmark specification reported in

[21] For Italy the regression specification modifies to

$$\text{Change}_{irt} = \alpha + \beta' \mathbf{z}_t + \gamma' \mathbf{x}_{irt} + \delta t + D_r + \varepsilon_{irt},$$

given that the survey frequency requires that we cumulate shocks $\mathbf{z}_t$ by year. Thus, the coefficients β are identified by annual variation where we control for a common linear time trend. In the specifications, in which we identify the effect of policy rate shocks by exploiting regional differences, we add interactions of the shocks $\mathbf{z}_t$ with a dummy for financially developed regions and control for aggregate time effects more flexibly by adding time dummies. The coefficients of interest are then identified by the region-year variation.

[22] We do not use aggregate variables as controls because doing so would contaminate our regression specification. For example, unemployment and real GDP growth affect monetary policy decisions and, simultaneously, are influenced by them so that these variables are endogenous. If our constructed monetary policy shocks are exogenous and thus are true surprises, which we have attempted to achieve with our construction of the series, omitted variables are uncorrelated with these shocks and do not bias the coefficient estimates.

[23] For Italy we can include less additional lags because we have less degrees of freedom. Given that the additional lags reduce the length of the sample period that we can use for our estimation, we display estimates in Table 22 in Appendix A.2.5 for the benchmark specification on the smaller sample for ease of comparison, together with the estimates for the specifications with the additional lags of the shocks.

Table 7, the different data frequencies across countries, as previously explained, imply that we control for year and quarter dummies for Germany and Switzerland and a linear time trend for Italy. We cluster standard errors by quarter of interview for Germany and Switzerland and by year for Italy because the monetary policy shocks do not vary at the household level. In Appendix A.2.6 we show that our results are robust if we add additional controls for household characteristics on which we presented descriptive evidence in Table 6. Thus, the observable heterogeneity in the sample composition in each of the considered countries does not explain the different transmission of monetary policy to the housing market across countries which we find.

Table 7: Effect of monetary policy shocks on housing tenure transitions

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.019	-0.024**	-0.032***	0.002	-0.003*	-0.017***
Monetary policy shock, sum Q(-5,-8)	-0.030*	0.065**	-0.017***	0.001	0.008	-0.004
Monetary policy shock, sum Q(-9,-12)	-0.025*	0.069***	-0.004	0.002	0.007**	0.003
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	67,431	5,677	21,039	71,251	22,219	24,777
Adjusted R^2	0.00	0.01	0.01	0.00	0.00	0.01
Cum. annualized effect (in pp) of 25 bp cut	1.82*	-1.37***	1.32***	-0.13	-0.15*	0.46***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

Table 7 shows that the monetary policy shocks affect housing tenure choices significantly in all countries.[24] The quantitative patterns are quite different though. The immediate effect on housing tenure transitions within a year of the shocks is strongest in Switzerland for the transitions from rental to owning and vice versa. This is in line with

[24]The low adjusted R^2 in Table 7 illustrates that much of the variation at the household level remains unexplained. This is not surprising because the only variable, that enters the regressions and varies at the household level, is age. Because our goal is to estimate the causal effect of policy rate shocks and not to predict the transitions, we have refrained from adding more variables in our benchmark specification that may improve the predictive power at the cost of introducing endogeneity issues. As previously discussed, omitted variable bias is not a concern given the exogeneity of the shocks.

our finding in subsection 4.2 that the pass-through of policy rate shocks to mortgage rates is strongest in Switzerland. The implied change of the user cost seems particularly relevant for younger households for their transition from rental to owning as subsequently discussed. The transitions from owning to renting seem driven more by the effect of the policy rate shock on price-rent ratios, given that this transition is more relevant for older households who are relatively less leveraged. As is is shown in the next Section 7, rents in Switzerland respond immediately and most strongly to the policy rate shocks, possibly because of the indexation of rents to mortgage rates discussed in Section 2.

The coefficients of the shocks with further lags in Table 7 reveal that the policy rate shocks affect the timing of housing tenure transitions in Italy but the effects are not persistent as in Switzerland and Germany. This is illustrated by the opposite sign of the coefficients of the shocks at short and longer lags in Italy compared with the same sign of these coefficients in Germany and Switzerland. In Germany, the policy rate shocks only affect the transition from owning to renting, and more so at longer lags. As we document in Section 7, this pattern is similar for the effect of the interest rate shocks on rents and house prices which is stronger at longer lags in Germany than in Italy and Switzerland.

In the bottom row of Table 7, we report the total effect of an unexpected 25 bp interest rate cut.[25] We find that the transition from renting to owning increases by $1-2$ pp in Germany and Switzerland. In Italy, the initial increase is more than offset over time, implying a decrease in the transition by 1.4 pp. The negative total effect in Italy becomes smaller (in absolute terms) and is insignificant if we use shocks to long-term yields on announcements dates instead of policy rate shocks, as shown in Table 19 in Appendix A.2.2. The pass-through of policy rate shocks to rates of long-term bonds and mortgages has been less effective in Italy during the sovereign debt crisis in our sample period, as discussed in Section 4.2.

Thus, the robust finding for Italy is that the transmission of interest rate changes to housing tenure transitions is weaker than in Germany and Switzerland, a result associated with the strong pass-through to house prices in the quarters after an interest rate cut, as shown in Table 10 in Section 7. Moreover, the descriptive evidence in Table 6 in Section 5 suggests that other determinants, such as (intergenerational) transfers across households, are associated with housing tenure transitions in Italy, which is in line with the much smaller incidence of mortgages. Thus, the smaller pass-through of monetary policy shocks to housing tenure transitions in Italy may not be surprising after all. Interestingly, the *relative* effect of the monetary policy shocks on housing tenure transitions across Italian regions with different financial development is more similar to the aggregate effects on

[25] Note that we use a change by 25 bp for the quantitative illustration. We do this because the response to shocks of this size is usually reported. The typical unexpected shock to the policy rate is much smaller in our sample period, as shown in Figure 1 in Section 3.

housing tenure transitions estimated for Germany and Switzerland, as discussed further in Section 8.

The bottom row of Table 7 further shows that an unexpected reduction in the interest rate increases the transition from owning to renting by 0.5 pp in Switzerland. For Germany and Italy, we find no strong effect on the transition from owning to renting. It decreases slightly and not significantly for Germany. For Italy, the decrease by 0.15 pp is only significant at the 10%-level.

When interpreting the size of the effects, it is important to recall that typical policy rate shocks are much smaller than 25 bp. As mentioned in Section 3, the standard deviation of the monetary policy shocks is 7 bp for the ECB and 10 bp for the SNB. Thus, the effects on the transitions reported in Table 7 must be scaled down by approximately one third if we consider a policy rate shock of one standard deviation. The scaled effects remain quantitatively relevant given that around 4 percent of renters become homeowners per year and $1-2$ percent of owners become renters, as we have shown in Figure 4 in Section 5.

Table 8 provides evidence on the heterogeneity of the transmission across groups with different ages, incomes and net worth. Information on the latter is only available in the German and Italian data. We choose to report the heterogeneity for age, income and net worth because the descriptive evidence presented in Table 6, Section 5, suggested that the subpopulations that change housing tenure status differ in these dimensions from the rest of the population. Furthermore, age, income and net worth are state variables in typical structural models of household financial behavior so that they are of particular interest. Table 8 displays the cumulated effects of an unexpected 25 bp cut by subgroup. The effect reported in each cell of the table is obtained by estimating the benchmark regression specification for each subgroup. The results for the entire sample are repeated in the first row for ease of comparison.

Table 8 confirms the suggestive descriptive evidence in Table 6. The results in columns 1 to 3 show that the policy rate shocks in Germany and Switzerland trigger more transitions from rental to owning for relatively younger households, for households with income higher than the median, and for households with a higher net worth (for Germany). The patterns for Italian households are less clear cut which is related to the finding that the response of the transition to homeownership has a more complicated timing and is different to Germany and Switzerland, as shown in Table 7.

Regarding the transition from owning to renting, columns 4 to 6 in Table 8 show that the sizable increase after a policy rate cut in Switzerland is caused by households with a head between ages 45 and 64 before retirement, particularly if they have a lower than median income. For Italy, a policy rate cut reduces the transition from owning to renting

Table 8: Cumulative effect of 25 bp cut on housing tenure transitions for groups with different ages, income and net worth

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Whole sample	1.82*	-1.37***	1.32***	-0.13	-0.15*	0.46***
By age group						
Age 25-44	2.94**	-1.59	1.14**	-0.17	-1.15***	-1.23*
Age 45-64	1.06	-0.77**	1.69***	-0.26	-0.06	1.41***
Age 65-84	-1.94	-1.92**	0.95***	-0.19	0.03	-0.26
By income, working age group (25-64),						
Working age group (25-64)	2.35**	-1.11***	1.28***	-0.16	-0.29**	0.75***
Incomes < median	0.52	-1.34***	0.58***	1.47*	-0.32*	-0.10
Incomes > median	3.77**	-0.72	1.82***	-0.82**	-0.20**	1.07***
Incomes < median (within age group):						
Age 25-44	0.25	-1.78*	0.16	6.38***	-2.15**	-4.14*
Age 45-64	0.31	-1.03*	0.89***	-0.78	0.11	1.77***
Age 65-84	-1.19	-1.37	-0.91**	-0.64	0.06	2.35***
Incomes > median (within age group):						
Age 25-44	4.69**	-0.94	1.88**	-2.48**	-0.48*	-0.04
Age 45-64	1.93	0.24	1.59**	-0.01	-0.12***	1.41***
Age 65-84	-3.10	-2.55	4.35***	0.27	0.06	-2.02***
By net worth, working age group (25-64),						
Working age group (25-64)	2.35**	-1.11***	-	-0.16	-0.29**	-
Net worth < median	1.32	-0.21	-	-0.44	-1.07***	-
Net worth > median	2.59**	-10.82***	-	-0.04	0.02	-
Net worth < median (within age group):						
Age 25-44	2.92**	-0.79***	-	-0.50	-7.64***	-
Age 45-64	0.31	0.17	-	-0.28	-0.44	-
Age 65-84	-2.44	-0.34	-	-1.15	0.07	-
Net worth > median (within age group):						
Age 25-44	2.70*	-7.49	-	0.13	-0.23**	-
Age 45-64	1.87	-14.40***	-	-0.24	0.11**	-
Age 65-84	-1.24	-4.39	-	0.02	0.05**	-

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The reported cumulative annualized effect is in pp. The estimates for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions. Subgroups consist of at least 105 observations. The typical subgroup has more than 1,000 observations.

for young households with lower income and net worth. Thus, the different response of the transition from owning to renting in Switzerland and Italy seems to be related to the higher homeownership rates of young households in Italy relative to Switzerland.

Given that some research has emphasized the importance of cultural factors for financial decisions of households, we exploit the diversity of languages within Switzerland to assess whether the patterns found across countries are also present within Swiss cantons across language groups. We assign the membership in a language group according to what the household head considers as the first language.[26] The reference language is Swiss German, and the dummies *German*, *French* and *Italian* refer to households in Switzerland with a German, French and Italian mother tongue, respectively. We add household controls to the regression because the descriptive statistics displayed in Tables 35 and 36 in Appendix A.5 show that language groups differ in observables such as age and income which may affect the response to monetary-policy shocks. We add canton dummies as further controls to capture differences across these cantons, for example in terms of regulations, and we also add canton-year dummies to capture changes in these regulations over time.

Table 9 shows that our benchmark results are robust to adding these additional controls, and that housing tenure transitions respond similarly to monetary policy shocks across language groups within Swiss cantons. For ease of comparison, columns 1 and 3 of Table 9 display the estimates for the effect of the monetary policy shocks on housing tenure transitions if we just add the household controls to the benchmark specification. In columns 2 and 4 of Table 9 we add interactions of the monetary policy shocks with dummies for the respective language group, and control for canton and canton-year fixed effects. The joint F-test for the significance of the language-shock interactions has a p-value higher than 18% for the regression on the transitions from renting to owning in column 2. For the regression on the transitions from owning to renting reported in column 4, households with French and Italian mother tongue do not respond differently to households with a Swiss-German mother tongue. The F-test for each group has a p-value higher than 42%. The only heterogeneity in the housing tenure responses across language groups which we detect is that households with a German mother tongue are more likely to transit from owning to renting after a interest rate cut than households with a Swiss-German mother tongue. The p-value of the F-test is 1% when we test the joint significance of the coefficients for the German-language interactions with the monetary policy shocks.

Overall, we find little evidence for different responses across language groups within

[26]The first language is reported for 19,474 out of 45,816 households. To ensure a sufficient sample size across quarters in the considered period, we assign the language according to the location of the residence for the remaining households. In Appendix A.5, Tables 35 and 36 show that the subsample of households who report a first language has similar observable characteristics across language groups as does the sample that we use.

Table 9: Effect of monetary policy shocks on housing tenure, across language groups in Switzerland

	Renter to owner		Owner to renter	
	(1)	(2)	(3)	(4)
Monetary policy shock, sum Q(-1,-4)	-0.029***	-0.036***	-0.018***	-0.020***
Monetary policy shock, sum Q(-5,-8)	-0.013***	-0.007	-0.008***	-0.008*
Monetary policy shock, sum Q(-9,-12)	-0.002	0.005	0.000	0.007
Monetary policy shock, sum Q(-1,-4) × German		-0.023		-0.004
Monetary policy shock, sum Q(-5,-8) × German		0.035		-0.048**
Monetary policy shock, sum Q(-9,-12) × German		0.028		-0.049
Monetary policy shock, sum Q(-1,-4) × Italian		-0.022		-0.015
Monetary policy shock, sum Q(-5,-8) × Italian		-0.035		0.002
Monetary policy shock, sum Q(-9,-12) × Italian		-0.050		-0.003
Monetary policy shock, sum Q(-1,-4) × French		0.024		0.013
Monetary policy shock, sum Q(-5,-8) × French		-0.019		0.003
Monetary policy shock, sum Q(-9,-12) × French		-0.030		-0.022
Household controls†	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Canton dummies	No	Yes	No	Yes
Canton-year dummies	No	Yes	No	Yes
Observations	21,039	21,039	24,777	24,777
Adjusted R^2	0.02	0.04	0.02	0.02
Cum. effect (in pp) of 25 bp cut	1.10***	0.95**	0.66***	0.53**

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. †: Household controls also use information on the household's reference person and include: age, age squared, household size, civil status, partnership, working status, gender, nationality, real household income. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Language interactions use the first language of the household's head; the reference language is Swiss-German. Standard errors are clustered by quarter of the interview, because the monetary policy shock does not vary at the household level. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

Switzerland. This finding suggests that cultural differences may not be of first-order importance for understanding the cross-country differences in the pass-through of monetary policy shocks to housing tenure transitions, which we reported in Table 7. Instead, the differences in housing markets across these countries discussed in Section 2, and the different pass-through of the monetary policy shocks to the mortgage interest rates discussed in Section 4.2 seem to play an important role.

6.1 Robustness

Appendix A.2 contains all of the robustness checks for the main regression specification reported in Table 7. We discuss the results to which we have not yet referred. In Appendix A.2.1, we provide robustness checks for alternative time windows around the policy announcements. Specifically, we construct policy rate shocks using six-hour time windows as in Corsetti et al. (2020) for constructing policy rate shocks, and 30-minute time windows as in Nakamura and Steinsson (2018). Table 16 in Appendix A.2.1 shows that the correlation between these shocks series and our benchmark series is high except for the series based on 30-minute time windows in the euro area. The communication of monetary policy by the ECB requires longer time windows than 30 minutes to capture all of the new information released. Thus, we report robustness checks for the euro-area countries Germany and Italy using the series for monetary policy shocks based on a six-hour time window, as in Corsetti et al. (2020). For Switzerland, we report the robustness results for both the shock series based on the six-hour and the 30-minute time window.

Tables 17 and 18 in Appendix A.2.1 show that the estimated effects on housing tenure transitions are robust to using the alternative time windows. The coefficient estimates tend to become larger if we use shocks based on shorter time windows. This result should be expected given the timing of the announcements and the subsequent press conferences which we have described in Section 3. The shocks are smaller if measured over shorter time windows because the full effect of the announcement takes longer to pass through to the futures market, particularly so for the very short 30-minute time window. We view the benchmark time window of one day, between the end of the announcement day and the day before, as a reasonable compromise between capturing the full effect of the monetary policy announcement on the futures prices and avoiding that other changes in that time window confound the results.

Table 19 in Appendix A.2.2 shows that the responses of housing tenure transitions from renting to owning are very similar in Germany and Switzerland if we use unexpected changes in the five-year government bond yields on the announcement days. For Italy, the responses become less different to Germany and Switzerland compared with our benchmark results. The remaining difference in the responses of housing tenure transitions

between Italy and the other two countries in Table 19 show that not only the transmission from policy rates to long-term yields, documented in Section 4.2, but also the transmission from long-term yields to housing tenure transitions is different in Italy relative to Germany and Switzerland.

Table 20 in Appendix A.2.3 and Table 21 in Appendix A.2.4, show that our results are robust if we exclude the years 2007/2008 of the financial crisis from our sample or the quarters with a negative interest rate policy (NIRP). The latter results suggest that the effect of monetary policy shocks on housing tenure transitions does not differ substantially in environments with low interest rates. To put this finding into perspective, note that recent research by Berger et al. (2018) and Eichenbaum et al. (2018) shows that the transmission of monetary policy depends on the interest rate level in the U.S. as a result of refinancing and prepayment of fixed-rate mortgages. This channel seems less important for the countries considered in our analysis, in which refinancing and prepayment of mortgages are much more costly. Moreover, the refinancing decision directly affects indebted homeowners and their expenditures but is less relevant for the decision of renters to become homeowners.

Table 25 in Appendix A.2.8 provides evidence that the effects of monetary policy shocks depend on the sign of the shocks. In Germany, unexpected rate cuts have a stronger effect on the transition from owning to renting but a more moderate effect on the transition from renting to owning. For Switzerland the effect of the unexpected rate cuts has a stronger effect on the transition from renting to owning instead. For Italy, unexpected rate increases have stronger effects on the housing tenure transitions. Evidence that is not reported for brevity shows that these asymmetries are associated with asymmetries in the transmission of monetary policy shocks to mortgage rates in Germany and Switzerland. In Germany, fixed-rate mortgage rates respond more strongly to unexpected rate increases. In Switzerland, policy rates and fixed-rate mortgage rates instead co-move more strongly for rate cuts in the considered sample period.

In Appendix A.2.9 we check the robustness of our results if we consider only monetary policy shocks that are negatively correlated with changes in stock market valuations, as measured by the Euro-Stoxx 50 and SMI, respectively.[27] Jarociński and Karadi (2020) have argued that this allows to separate policy rate shocks from news shocks that may be associated with monetary policy announcements. Hence, we require that an accommodative shock, for example, unexpectedly lowers interest rates and simultaneously increases the stock market valuation as predicted by standard asset pricing theory. If such a shock is

[27] The correlation coefficient of the daily returns of the DAX and the MIB, respectively, with the daily returns of the Euro-Stoxx 50 is higher than 0.9, regardless of whether we use all daily returns in the sample period or only those on the announcement dates. Thus, we do not distinguish the stock-market index for Germany and Italy when constructing the shock series.

instead associated with a decrease in the stock market valuation, we take this as a sign that the monetary policy announcement revealed also news about a worse economic outlook.

Distinguishing interest rate shocks from news shocks in this way, the results in Table 26 in Appendix A.2.9, show that both interest rate and news shocks matter for housing tenure transitions. The effect on housing transitions tends to become stronger in Germany and Switzerland for the interest rate shocks relative to our benchmark results but the overall pattern of the estimates remains unchanged. Larger estimates are consistent with the interpretation that some news shocks offset part of the effect of interest rate shocks on housing tenure transitions. Table 26 in Appendix A.2.9 further reveals that the response to news shocks is quantitatively the strongest in Switzerland.

7 The response of rents and house prices

Interest rate shocks affect both housing tenure decisions and prices of housing units. In this section we estimate the effects of policy rate shocks on rental expenditures and housing values for Germany, Italy and Switzerland. Information on the value of housing is available at the household level for Germany and Italy but not for Switzerland, as further explained in the data appendix A.5. Thus, we complement the evidence based on household-level data for Germany and Italy with evidence based on aggregate data for Switzerland.

Table 10 shows the effect of monetary policy shocks on rents (columns 1 to 3) and housing values (columns 4 to 6). The bottom row shows that an unexpected decrease of the interest rate reduces rents (but for Germany) and increases house prices.[28] Standard asset pricing theory tells us that the fundamental value of housing is determined by the present discounted value of rents.[29] If rents decrease, house prices may increase if the pass-through to interest rates, used for discounting the rents, is strong in the aftermath of the policy rate shocks, as documented in Section 4. Thus, the response of the fundamental value of housing depends on the size and persistence of the response of rents relative to interest rates.

In standard monetary transmission models with housing surveyed by Piazzesi and Schneider (2016), an unexpected cut of the interest rate is expansionary and increases

[28] We have investigated whether the changes in the values indeed reflect price effects and not changes in quantities. We have run the regressions on subsamples in the household data for which we have information for Germany and Italy on whether households have moved between survey waves. The results are not reported for brevity. We have found that the difference in the response of rents in Germany and Italy relative to Switzerland, which we report in Table 10, is robust if we consider only households that did not move between survey years. This suggests that price effects shape this difference.

[29] With an infinite horizon and stable rents and interest rates, the fundamental house value simplifies to the ratio of the rent to the interest rate.

Table 10: Effect of monetary policy shocks on rents and house prices

	Rents			Housing value / House price		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland[†]
Monetary policy shock, sum Q(-1,-4)	-0.054	-0.068	0.090***	0.022	-0.252**	-0.021
Monetary policy shock, sum Q(-5,-8)	-0.075	0.229	0.049**	-0.114	0.162	-0.024**
Monetary policy shock, sum Q(-9,-12)	-0.117*	-0.006	-0.000	-0.150**	-0.098	-0.009
Age controls	Yes	Yes	Yes	Yes	Yes	-
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	70,189	12,152	22,918	4,135	42,953	60
Adjusted R^2	0.01	0.02	0.02	0.02	0.03	0.99
Cum. effect (in percent) of 25 bp cut	6.15*	-3.88	-3.50***	6.04	4.71	1.36*

Notes: [†] Aggregate, quarterly data for Switzerland because no available household-level data. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable in columns 1 to 3 is the log of real annual rent expenditures converted to adult-equivalent units using the equivalent scale detailed in Appendix A.5. The dependent variable in columns 4 and 5 is the log of the deflated house price (2010 euros). Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The dependent variable in column 6 is the price index for flats in Switzerland retrieved from the BIS (Property prices statistics, reference *Q:CH:0:8:0:2:0:0*). The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

consumption of housing and non-housing goods. Hence, one would expect that rents and house prices move in tandem. Our evidence, that rents decrease in Switzerland and also somewhat in Italy whereas the value of housing increases in both countries, suggests that borrowing constraints and market segmentation let prices of rented and owned units respond differently. Using aggregate data, Corsetti et al. (2018) and Dias and Duarte (2019) show that the opposite response of rents and house prices to interest rate shocks also holds for the euro area and the U.S., respectively.[30]

Regarding house prices, columns 4 to 6 of Table 10 show that the effects of the policy rate shocks have a different timing across the three countries. The point estimates for the effect of a 25 bp cut are large, between 1.4 and 6 percent. Corsetti et al. (2020), Figure 8, report responses based on aggregate data for Germany and Italy that are an order of magnitude smaller. We also find smaller coefficients, in regressions not reported for brevity, if we use aggregate house price indexes for Germany and Italy. Hence, we do not interpret the cross-country differences in the size of the estimated effects because the underlying data series are differently measured. For Germany and Italy the estimates are based on household-level survey data (Appendix A.5 describes the house price measures). For Switzerland, no such data are available so that the estimates in column 6 are based on an aggregate, quarterly price index for flats. Keeping in mind these caveats, it is still interesting to note that the strong increase of house prices in Italy in the year after a policy rate cut, displayed in column 5 of Table 10, is associated with the pattern in the response of the transition from renting to owning, which we reported in column 2 of Table 7 in Section 6. The coefficients of this response change sign for different lags of the shocks, suggesting that price effects may shape the pattern of the response over time by offsetting the immediate effect on the transitions resulting from the quick pass-through of the policy rate shocks to mortgage interest rates documented in subsection 4.2.

For rents, the data series are comparable across countries. Columns 1 to 3 of Table 10 show that rents respond strongest in Switzerland within the first year after the shock and the pass-through occurs within two years. The pass-through within the first year after the shock is weaker in Germany and Italy, and the pass-through across all lags of the shock series is much less precisely estimated in these countries. In the bottom row of Table 10 we report that an unexpected 25 bp cut of the policy rate reduces rents by 3.5 percent in Switzerland. The effect for the other two countries is less clear. The point estimate for Italy is of similar size but not estimated precisely enough to be significant at the 10% level. For Germany, rents seem to increase rather than decrease after a policy rate cut but this effect is very noisily estimated. In Appendix A.3 we check robustness of

[30]Given that these papers consider the response of nominal rents, it is worth noting that the results on the response of rents reported in Table 10 are quantitatively very similar if we use nominal rents as dependent variable.

the results reported in Table 10 if we choose different time windows for constructing the policy rate shocks as in Corsetti et al. (2020) for the ECB and SNB as well as in Nakamura and Steinsson (2018) for the SNB.

One possible reason for the strong and precisely estimated pass-through of policy rate shocks to rents in Switzerland is that rents are indexed to mortgage rates in Switzerland (see Section 2) and that the pass-through of the policy rate shocks to the mortgage rates is strongest in Switzerland (see Table 3 in subsection 4.2). To understand further what may cause the different responses of rents across countries, we investigate the response of rents by landlord type. We do this for Germany because the SOEP provides information on the landlord type since 2013.[31]

Table 27 in Appendix A.3 shows that an unexpected cut of the policy rate in Germany reduces rents differently depending on the ownership type. We find that the pass-through to rents of publicly owned housing seems to differ from housing units with other ownership types. As mentioned in Section 2, publicly owned housing accounts for one third of the rental housing stock in Germany, for one fifth in Italy and only for one tenth in Switzerland. The results in Table 27 suggest that this may explain part of the differences in the pass-through to rents between Germany and Switzerland.

Further robustness checks presented in greater detail in Appendix A.3 show that the findings reported in Table 10 are robust to using different time windows and shocks to yields of five-year government bonds. Only the response of rents in Italy then changes sign, but remains imprecisely estimated.

Together with the evidence on housing tenure transitions presented in Section 6, our findings suggests that the stronger pass-through to mortgage rates in Switzerland relative to Germany and Italy triggered more transitions to homeownership within one year after an unexpected interest rate cut and an increase in the relative price of owning.

8 The transmission across Italian regions

In subsection 4.2 we uncovered heterogeneity across Italian regions with different financial development in terms of the pass-through of the policy rate shocks to mortgage interest rates. Also the incidence of mortgages is different: 17.5% in financially developed regions compared with 14.2% in less developed regions. We now exploit this heterogeneity to estimate the monetary transmission to the housing market based on an alternative identification. The estimated effects are identified by region-year variation. The interpretation of the coefficients is different to the aggregate effects estimated in our analysis

[31] Information on landlord type is not available in the SHP in Switzerland. In the SHIW for Italy, the sample size of renters is too small to provide insights by distinguishing the ownership type of rental units.

so far because the effects are measured relative to a benchmark region rather than in absolute terms. The common intercept across regions included in the aggregate effect is differenced out. The approach of identifying the effects of macroeconomic policy using regional variation is similar to the estimation of relative fiscal multipliers by Nakamura and Steinsson (2014) for U.S. regions.

Table 11: Baseline regression results for regional effects in Italy

	Renter to owner	Owner to renter	Rents	House prices	Mortgage rate
Monetary policy shock, sum Q(-1:-4) × Developed	-0.061***	-0.004	-0.081**	0.006	0.449**
Monetary policy shock, sum Q(-5:-8) × Developed	0.066	-0.005	0.382***	0.154	0.646
Monetary policy shock, sum Q(-9:-12) × Developed	-0.024	-0.005	0.241***	0.127	0.114
Developed dummy	-0.026***	-0.002	0.525***	0.196***	-0.367***
Age controls	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	5,645	22,142	12,085	42,765	2,493
Adjusted R^2	0.01	0.00	0.12	0.06	0.18
Cum. relative effect of 25 bp cut	0.23 pp	0.17 pp	-13.54*** percent	-7.17 percent	-0.30* pp

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not, in the tenure transition regressions. Log real annual rent expenditures are normalized by household size using the equivalent scale detailed in data appendix A.5, the log real house price and log real rent expenditures are in units of euro in 2010, and the average variable mortgage rate is in percent. Standard errors are clustered by year. Age controls include age and age squared and refer to the household's reference person. The cumulative relative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative relative effects for Italy based on biannual transitions are adjusted to be comparable with those based on annual transitions.

Table 11 displays the effect of monetary policy shocks on housing tenure transitions (columns 1 and 2), rents (column 3), house prices (column 4) and mortgage rates (column 5) in financially more developed Italian regions relative to the less developed regions. The results in column 5 confirm our finding from subsection 4.2 that the pass-through to mortgage rates is stronger in financially more developed regions. Column 5 shows results for households with variable-rate mortgage contracts in the SHIW whereas in subsection 4.2 we provided results for fixed-rate mortgage rates of new mortgage contracts.[32] Table 11 shows that the stronger pass-through to mortgage rates is associated with more transitions from renting to owning, a stronger reduction in rents, and no significantly different house price reactions in financially more developed regions than in less developed regions. Interestingly, the stronger pass-through to rents in financially more developed regions is associated with lower public ownership of rental housing (18% compared with 24%, based on information in the SHIW available for 2014 and 2016).

These results show that the effect of the monetary policy shocks on housing tenure transitions in the financially more developed Italian regions *relative* to the less developed

[32]Results, which are not reported for brevity, show that the pass-through to fixed-rate mortgage contracts of existing mortgagors is not different across regions. Adjustments of the contract rates for mortgages originated prior to the shocks are less relevant for the transition from renting to owning.

regions is more similar to the aggregate effects on housing tenure which we estimated for Germany and Switzerland. This finding suggests that regional differences in the transmission of monetary policy shocks to mortgage interest rates and the user cost of homeownership help to explain regional differences in housing tenure transitions in Italy although the aggregate effect of housing tenure transitions in Italy seems to be explained less well by these determinants.

Thus, the results based on regional variation within Italy qualitatively tell a similar story as the evidence across countries. Differences in the pass-through of monetary policy to mortgage rates, associated with a different incidence of mortgages, imply substantial heterogeneity in the transmission of monetary policy to the housing market. In Appendix A.4, we show that the results based on the regional variation are robust if we use different time windows for constructing monetary policy shocks as in Corsetti et al. (2020), if we use changes of long-term bond yields on the announcement dates as measures of the shocks, and if we vary the cut-off for classifying Italian regions as financially developed.

9 Conclusion

We have shown that the transmission of monetary policy to the housing market differs substantially across Germany, Italy, and Switzerland, and across regions within Italy. We have found differences in the pass-through of monetary policy shocks to mortgage rates, housing tenure transitions, rents and house prices. Our analysis indicates that differences in the incidence of mortgagors and renters; institutional features such as indexing rents to mortgage rates; and the extent of public housing shape the monetary policy transmission to the housing market.

From an applied theoretical point of view, our results help to discipline structural models that analyze monetary policy considering features of the housing market. The rich heterogeneity, that we have started to uncover in our analysis, hopefully will motivate additional empirical analysis. For the conduct of monetary policy, understanding the causes of the different pass-throughs to mortgage interest rates across regions, that we have documented, seems an important step for further research.

10 Bibliography

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., and Ragusa, G. (2019). Measuring Euro Area Monetary Policy. *Journal of Monetary Economics*, 108(C):162–179.

Andrews, D. and Sánchez, A. C. (2011a). Drivers of Homeownership Rates in Selected OECD Countries. OECD Economics Department Working Papers 849, OECD, Paris.

Andrews, D. and Sánchez, A. C. (2011b). The Evolution of Homeownership Rates in Selected OECD Countries: Demographic and Public Policy Influences. *OECD Journal: Economic Studies*, 1:207–243.

Auclert, A. (2019). Monetary Policy and the Redistribution Channel. *American Economic Review*, 109(6):2333–2367.

Badarinza, C., Campbell, J. Y., and Ramadorai, T. (2018). What Calls to ARMs? International Evidence on Interest Rates and the Choice of Adjustable-Rate Mortgages. *Management Science*, 64(5):2275–2288.

Basten, C. and Koch, C. (2015). The Causal Effect of House Prices on Mortgage Demand and Mortgage Supply: Evidence from Switzerland. *Journal of Housing Economics*, 30:1–22.

Beraja, M., Fuster, A., Hurst, E., and Vavra, J. (2018). Regional Heterogeneity and the Refinancing Channel of Monetary Policy. *Quarterly Journal of Economics*, 133:109–183.

Berger, D. W., Milbradt, K., Tourre, F., and Vavra, J. (2018). Mortgage Prepayment and Path-Dependent Effects of Monetary Policy. *NBER Working Paper No. 25157*.

BFS (2013). Haushaltsbudgeterhebung 2011: Kommentierte Ergebnisse und Tabellen. *BFS Aktuell, July*.

Calza, A., Monacelli, T., and Stracca, L. (2013). Housing Finance and Monetary Policy. *Journal of the European Economic Association*, 11:101–122.

Cesa-Bianchi, A., Thwaites, G., and Vicondoa, A. (2020). Monetary Policy Transmission in the United Kingdom: a High Frequency Identification Approach. *European Economic Review*, 123:103375.

Christelis, D., Georgarakos, D., and Haliassos, M. (2013). Differences in Portfolios across Countries: Economic Environment versus Household Characteristics. *Review of Economics and Statistics*, 95(1):220–236.

Cloyne, J., Ferreira, C., and Surico, P. (2020). Monetary Policy when Households have Debt: New Evidence on the Transmission Mechanism. *Review of Economic Studies*, 87(1):102–129.

Cochrane, J. H. and Piazzesi, M. (2002). The Fed and Interest Rates - A High-Frequency Identification. *American Economic Review*, 92(2):90–95.

Cook, T. and Hahn, T. (1989). The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s. *Journal of Monetary Economics*, 24(3):331–351.

Corsetti, G., Duarte, J. B., and Mann, S. (2018). One Money, Many Markets: A Factor Model Approach to Monetary Policy in the Euro Area with High-Frequency Identication. Working paper, Mimeograph.

Corsetti, G., Duarte, J. B., and Mann, S. (2020). One Money, Many Markets: Monetary transmission and Housing Financing in the Euro Area. Working paper, Mimeograph.

Dias, D. A. and Duarte, J. B. (2019). Monetary Policy, Housing Rents, and Inflation Dynamics. *Journal of Applied Econometrics*, 34:673–687.

Diaz, A. and Luengo-Prado, M. J. (2008). On the User Cost and Homeownership. *Review of Economic Dynamics*, 11(3):584–613.

ECB (2009). Housing Finance in the Euro Area. Working paper, European Central Bank, Occasional Paper Series, No. 101.

Eichenbaum, M., Rebelo, S., and Wong, A. (2018). State Dependent Effects of Monetary Policy: the Refinancing Channel. *NBER Working Paper No. 25152*.

Fernandez-Villaverde, J. and Krueger, D. (2007). Consumption over the life cycle: Facts from consumer expenditure survey data. *The Review of Economics and Statistics*, 89(3):552–565.

Fuster, A. and Zafar, B. (2021). The Sensitivity of Housing Demand to Financing Conditions: Evidence from a Survey. *American Economic Journal: Economic Policy*, 13(1):231–265.

Galí, J. (2015). *Monetary Policy, Inflation, and the Business Cycle: an Introduction to the New Keynesian Framework and its Applications*. Princeton University Press.

Gerko, E. and Rey, H. (2017). Monetary Policy in the Capitals of Capital. *Journal of the European Economic Association*, 15(4):721–745.

Gertler, M. and Karadi, P. (2015). Monetary Policy Surprises, Credit Costs, and Economic Activity. *American Economic Journal: Macroeconomics*, 7(1):44–76.

Goebel, J., Grabka, M. M., Liebig, S., Kroh, M., Richter, D., Schröder, C., and Schupp, J. (2019). The German Socio-Economic Panel (SOEP). *Journal of Economics and Statistics (Jahrbuecher fuer Nationaloekonomie und Statistik)*, 239(2):345–360.

Greenwald, D. L. and Guren, A. (2019). Do Credit Conditions Move House Prices? Manuscript, Boston University.

Guiso, L., Sapienza, P., and Zingales, L. (2004). Does Local Financial Development Matter? *Quarterly Journal of Economics*, 119(3):929–969.

Gürkaynak, R. S., Sack, B., and Swanson, E. (2005). Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1):55–93.

Haliassos, M., Jansson, T., and Yigitcan (2017). Incompatible European Partners? Cultural Predispositions and Household Financial Behavior. *Management Science*, 63(11):3780–3808.

Hedlund, A., Karahan, F., Mitman, K., and Ozkan, S. (2016). Monetary Policy, Heterogeneity and the Housing Channel. Working paper, Mimeograph.

Hintermaier, T. and Koeniger, W. (2018). Differences in Euro-Area Household Finances and their Relevance for Monetary-Policy Transmission. CESifo Working Paper No. 7088.

Iacoviello, M. (2005). House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle. *American Economic Review*, 95(3):739–764.

Jarociński, M. and Karadi, P. (2020). Deconstructing Monetary Policy Surprises: the Role of Information Shocks. *American Economic Journal: Macroeconomics*, 12(2):1–43.

Kaas, L., Korchakov, G., Preugschat, E., and Siassi, N. (2021). Low Homeonership in Germany: a Quantitative Exploration. *Journal of the European Economic Association*.

Kaplan, G., Mitman, K., and Violante, G. L. (2020). The Housing Boom and Bust: Model Meets Evidence. *Journal of Political Economy*, 128:3285–3345.

Kaplan, G. and Violante, G. (2014). A Model of the Consumption Response to Fiscal Stimulus Payments. *Econometrica*, 82(4):1199 – 1239.

Koeniger, W., Valladares-Esteban, A., and Weiss, J. (2021). Tax Incentives, Mortgage Amortization and Economic Stability. Manuscript, University of St.Gallen.

Kuttner, K. N. (2001). Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market. *Journal of Monetary Economics*, 47(3):523–544.

Ma, E. and Zubairy, S. (2021). Homeownership and Housing Transitions: Explaining the Demographic Composition. *International Economic Review*.

Nakamura, E. and Steinsson, J. (2014). Fiscal Stimulus in a Monetary Union: Evidence from US Regions. *American Economic Review*, 104(3):753–792.

Nakamura, E. and Steinsson, J. (2018). High Frequency Identification of Monetary Non-Neutrality: The Information Effect. *Quarterly Journal of Economics*, 133(3):1283–1330.

Piazzesi, M. and Schneider, M. (2016). Housing and Macroeconomics. In *Handbook of Macroeconomics*, volume 2, pages 1547–1640. Elsevier.

Ranaldo, A. and Rossi, E. (2010). The Reaction of Asset Markets to Swiss National Bank Communication. *Journal of International Money and Finance*, 29:486–503.

Rudebusch, G. D. (1998). Do Measures of Monetary Policy in a VAR Make Sense? *International Economic Review*, 39:907–931.

Schularick, M., ter Steege, L., and Ward, F. (2020). Leaning against the Wind and Crisis Risk. CESifo Working Paper No. 8484.

Slacalek, J., Tristani, O., and Violante, G. L. (2020). Household Balance Sheet Channels of Monetary Policy: a Back of the Envelope Calculation for the Euro Area. *Journal of Economic Dynamics and Control*, 115(103879).

Söderlind, P. (2010). Reaction of Swiss Term Premia to Monetary Policy Surprises. *Swiss Journal of Economics and Statistics (SJES)*, 146(I):385–404.

Voorpostel, M., Tillman, R., Lebert, F., Kuhn, U., Lipps, O., Ryser, V.-A., Antal, E., Monsch, G.-A., N, D., and Wernli, B. (2017). Swiss Household Panel User Guide (1999-2016). *Wave 18, December 2017. Lausanne: FORS*.

Wong, A. (2019). Refinancing and the Transmission of Monetary Policy to Consumption. Working paper, Mimeograph.

Woodford, M. (2012). Inflation Targeting and Financial Stability. *Sveriges Riksbank Economic Review*, (1):7–32.

A Appendix

A.1 Further evidence on interest rate shocks

Table 12: Properties of cumulated ECB interest rate shocks

	Raw	Cumulated by		
	series	Quarter	Semester	Year
Mean	0.001	0.002	0.004	0.008
Median	0.000	-0.003	0.013	-0.000
Standard deviation	0.072	0.127	0.162	0.208
Min	-0.225	-0.465	-0.650	-0.615
Max	0.280	0.420	0.335	0.335
Observations	229	72	36	18

Table 13: Properties of cumulated SNB interest rate shocks

	Raw	Cumulated by		
	series	Quarter	Semester	Year
Mean	-0.028	-0.034	-0.068	-0.136
Median	-0.010	-0.010	-0.030	-0.060
Standard deviation	0.099	0.141	0.170	0.247
Min	-0.510	-0.860	-0.780	-0.900
Max	0.170	0.310	0.230	0.160
Observations	87	72	36	18

Tables 12 and 13 show that the properties of the raw shock series are retained in the series with cumulated shocks. The mean and standard deviation become larger if the shocks are cumulated over longer periods, as documented in table 1 of Wong (2019) for the U.S.

We check whether the constructed monetary policy shocks are true shocks and thus not predictable by past values of the shocks. As mentioned in Section 3, private information of the monetary policy maker may introduce some persistence in our constructed series of shocks. Table 14 reports results of regressions of the monetary policy shocks on their lagged values. Columns 1 and 3 show results for regressions of the current quarterly shock on its past values for the ECB and the SNB, respectively. Columns 2 and 4 show regression results for the cumulated shock series where we check whether future shocks

can be predicted by past values at different horizons. As mentioned in the main text in Section 3, the results by and large support that our constructed series of the shocks are not predictable by past values and thus are true shocks.

In our main regression specifications, we cumulate shocks for every year. Figure 5 shows that for these moving sums of the shocks, the autocorrelations are not significant beyond two quarters. Hence, multicollinearity of the lagged shocks in the regressions is not a concern.

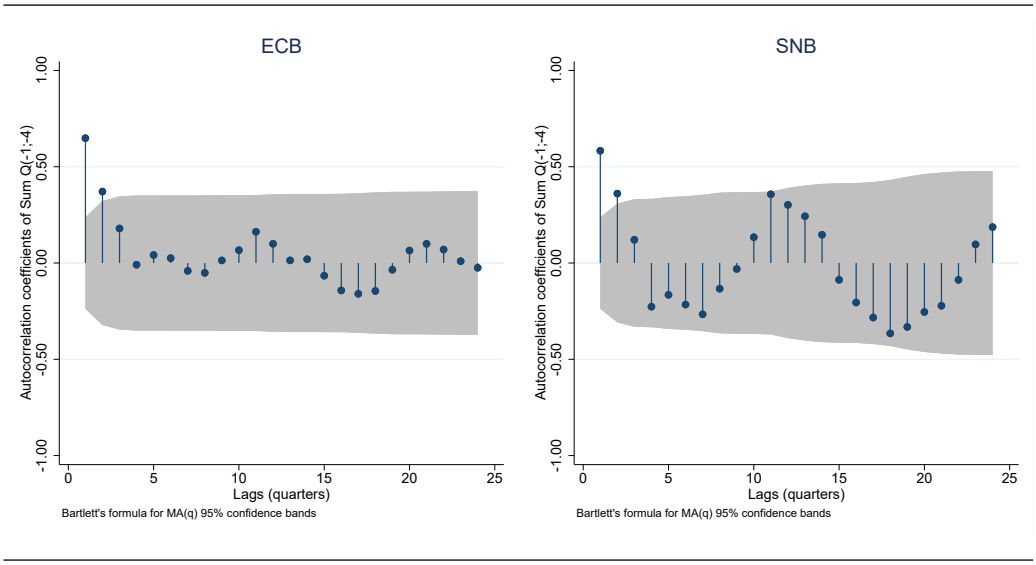
In Figure 6 we provide evidence that the three-month Euribor is highly correlated with the midpoint of the ECB policy rates, the rate on the main refinancing operations.

Table 15 shows that the pass-through of policy rate shocks to mortgage interest rates is stronger for Italy if we restrict the sample to shocks that are positively correlated with long-term yields. As mentioned in subsection 4.2 in the main text, this suggests that the pass-through to mortgage rates has been weaker in Italy during the euro-area debt crisis.

Table 14: Regressions of current and future monetary policy shocks on past shocks

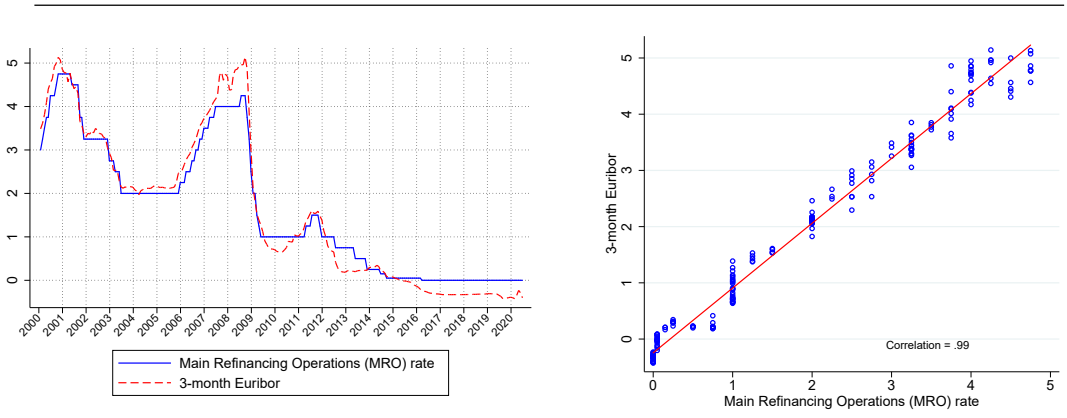
	(1)	(2)	(3)	(4)
	ECB, Current quarterly shock	ECB, Summed shocks in Q(+1,+4)	SNB, Current quarterly shock	SNB, Summed shocks in Q(+1,+4)
Monetary policy shock, Q(-1)	-0.146		-0.190	
	(-1.16)		(-1.52)	
Monetary policy shock, Q(-2)	-0.128		-0.072	
	(-1.01)		(-0.56)	
Monetary policy shock, Q(-3)	-0.053		0.008	
	(-0.45)		(0.06)	
Monetary policy shock, Q(-4)	0.068		-0.104	
	(0.59)		(-0.87)	
Monetary policy shock, sum Q(-1,-4)		0.025		-0.170
		(0.18)		(-1.23)
Monetary policy shock, sum Q(-5,-8)		0.0101		0.028
		(0.08)		(0.19)
Monetary policy shock, sum Q(-9,-12)		0.014		0.275*
		(0.11)		(2.00)
Observations	68	56	68	56
R^2	0.04	0.00	0.05	0.12

Notes: * p<0.10, ** p<0.05, *** p<0.01. Standard errors in brackets. Dependent variables are indicated at the top of the respective columns. All regressions include a constant. *Current shock* refers to the sum of the shocks that take place in a given quarter. *Sum Q(+1,+4)* denotes shocks cumulated over the next four quarters.



Notes: Correlograms of the moving sum of the quarterly shocks cumulated over a year.

Figure 5: Correlograms of the cumulated shock series



Sources: Euribor and MRO rates from Thomson Reuters (Y03728 and S245UE). We plot the values at the end of each month for both series.

Figure 6: Euribor and the rate on main refinancing operations (MRO) of the ECB

Table 15: Pass-through of policy rate shocks to five-year fixed-rate mortgage rates using shocks positively correlated with long-term yields

	Germany	Italy	Switzerland
Monetary policy shocks, sum M(0)	0.012	−0.073	0.844*** †
Monetary policy shocks, sum M(-1)	0.288***	0.361*	−0.012
Monetary policy shocks, sum M(-2)	0.232**	0.411*	0.046
Cum. effect of 25 bp cut	−0.133***	−0.175*	−0.219***
Monetary policy shocks, sum M(0)	0.005	−0.052	0.845*** †
Monetary policy shocks, sum M(-1)	0.267***	0.396**	−0.012
Monetary policy shocks, sum M(-2)	0.261**	0.406	0.044
Monetary policy shocks, sum M(-3)	0.049	0.043	0.034
Cum. effect of 25 bp cut	−0.146***	−0.199*	−0.227***

Sources: Rates of five-year fixed-rate mortgages from the ECB (Germany *MIR.M.DE.B.A2C.O.R.A.2250.EUR.N*, Italy *MIR.M.IT.B.A2C.O.R.A.2250.EUR.N*) and the SNB (*EPB@SNB.zikrepro{M,50}*) . *Notes:* Regression of monthly mortgage-rate changes on policy rate shocks cumulated by month. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The series are based on the monthly changes in the rates available for the period 2008M1-2017M12 in Switzerland and 2003M1-2017M12 in the euro area. The cumulative effect over three years of a -25 bp shock is computed by multiplying the sum of the coefficients by -0.25.

† Regular policy announcements at the SNB take place once a quarter. For the months without an announcement the value of the shock is zero.

A.2 Robustness of response of housing tenure

A.2.1 Different time windows around the policy announcements

We check robustness of the effect of policy rate shocks on housing tenure transitions if we use different time windows around the policy announcement. As alternatives to our benchmark of daily time windows, we use shorter time windows around the announcements, i.e., the six-hour time window used by Corsetti et al. (2020) for constructing interest rate shocks for the ECB, and the 30-minute window used by Gertler and Karadi (2015) and Nakamura and Steinsson (2018) for constructing interest rate shocks for the Federal Reserve. For a description of the timing of the policy announcements see Section 3.

Table 16 shows the correlation between shock series that use different time windows on the days of the monetary policy announcements of the ECB and SNB, respectively. We compute the correlations for the raw series of shocks (one observation per policy announcement), and for the series with the shocks cumulated to quarters, semesters or years. The table shows that our benchmark series for monetary policy shocks in Switzerland is highly correlated if we use the alternative time windows with correlation coefficients of 0.94 and 0.86 for the shock series based on the six-hour and the 30-minute time window, respectively. For the euro area, the correlation between our benchmark raw series of the shocks and the series based on the six-hour time window is 0.7. The correlation between our benchmark series and the series based on the 30-minute window is smaller at 0.34. This illustrates that the communication of monetary policy by the ECB requires longer time windows for constructing interest rate shocks because the very short time window of 30 minutes does not capture all the new information which is released.

We thus report robustness checks for the euro-area countries Germany and Italy using the series for monetary policy shocks based on a six-hour time window, as in Corsetti et al. (2020). For Switzerland, we report robustness results for both the shock series based on the six-hour and the 30-minute time window.

Table 16 further shows that cumulation of the monetary policy shocks reduces the correlation between the series based on alternative time windows, as shocks partially wash out when they are cumulated. This is less the case for Switzerland than for the euro area.

Tables 17 and 18 display the results for the effect of the policy shocks on housing tenure transitions, using the shocks constructed with the alternative time windows mentioned above.

Table 16: Correlation of benchmark with series for interest rate shocks using different time windows

Correlation of benchmark with series using time windows as in	ECB		SNB	
	Corsetti et al. (2020)	Nakamura and Steinsson (2018)	Corsetti et al. (2020)	Nakamura and Steinsson (2018)
Raw series	0.695***	0.337***	0.944***	0.857***
Cumulated by				
... quarter	0.673***	0.330***	0.949***	0.902***
... semester	0.434***	0.150	0.935***	0.825***
... year	0.268	0.251	0.935***	0.807***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Correlations of the benchmark with shock series using different time windows, for the respective raw series of shocks and when cumulated for various frequencies.

Table 17: The effect of monetary policy shocks on housing tenure transitions, using the time window as in Corsetti et al. (2020) for constructing the shocks

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.013	0.453***	-0.061	-0.001	0.033**	-0.071***
Monetary policy shock, sum Q(-5,-8)	-0.009	-0.006	-0.048	-0.003	-0.008**	-0.065***
Monetary policy shock, sum Q(-9,-12)	-0.018	0.192**	-0.026	-0.004	0.036**	0.012
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	67,521	5,677	21,039	71,320	22,219	24,777
Adjusted R^2	0.00	0.01	0.01	0.00	0.00	0.01
Cum. effect (in pp) of 25 bp cut	0.99	-7.97***	3.37	0.19	-0.76**	3.08***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

Table 18: The effect of monetary policy shocks on housing tenure transitions in Switzerland, time window as in Nakamura and Steinsson (2018) for constructing the shocks

	Renter to owner		Owner to renter	
	Baseline	Nakamura and Steinsson (2018)	Baseline	Nakamura and Steinsson (2018)
Monetary policy shock, sum Q(-1,-4)	-0.0322***	-0.0680**	-0.0172***	-0.0827***
	(-8.49)	(-2.03)	(-4.93)	(-3.33)
Monetary policy shock, sum Q(-5,-8)	-0.0165***	-0.0810*	-0.00389	-0.0252*
	(-4.07)	(-2.00)	(-1.34)	(-1.82)
Monetary policy shock, sum Q(-9,-12)	-0.00411	-0.00233	0.00253	0.00979
	(-1.54)	(-0.08)	(1.14)	(0.73)
Age	Yes	Yes	Yes	Yes
Age squared	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	21039	21039	24777	24777
Adjusted R^2	0.01	0.01	0.01	0.01
Cum. effect (in pp) of 25 bp cut	1.32***	3.78**	0.46**	2.45***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The effects are larger for the Nakamura and Steinsson (2018)'s time window by construction as the series have a smaller variance than the baseline series.

A.2.2 Using shocks to long-term yields

Table 19: The effect of monetary policy shocks on housing tenure transitions using five-year government bond yield changes on announcement dates

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
5y yield change on announcement date, sum Q(-1,-4)	-0.020	0.038	-0.058***	0.005	0.003	-0.023***
5y yield change on announcement date, sum Q(-5,-8)	-0.031**	-0.025	-0.027***	0.003	-0.001	-0.004
5y yield change on announcement date, sum Q(-9,-12)	-0.017	0.006	0.008	-0.000	0.004	0.008
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	67,431	5,677	21,039	71,251	22,219	24,777
Adjusted R^2	0.00	0.00	0.01	0.00	0.00	0.00
Cum. effect (in pp) of 25 bp cut	1.68**	-0.25	1.94***	-0.20	-0.07	0.48

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

A.2.3 Excluding financial crisis years

Table 20: The effect of monetary policy shocks on housing tenure transitions without financial crises years 2007/08

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.014	0.014	-0.033***	0.003	-0.012***	-0.019***
Monetary policy shock, sum Q(-5,-8)	-0.027	0.058*	-0.017***	0.001	0.010***	-0.005
Monetary policy shock, sum Q(-9,-12)	-0.024*	0.063***	-0.005*	0.001	0.009***	0.003
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	59,106	4,894	18,550	61,698	19,293	21,932
Adjusted R^2	0.00	0.01	0.01	0.00	0.00	0.01
Cum. effect (in pp) of 25 bp cut	1.62*	-1.69***	1.38***	-0.14	-0.08**	0.51***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

A.2.4 Excluding periods with negative interest rate policies

Table 21: The effect of monetary policy shocks on housing tenure transitions excluding quarters with a negative interest rate policy (NIRP)

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.017	-0.020**	-0.032***	-0.002	-0.003***	-0.017***
Monetary policy shock, sum Q(-5,-8)	-0.029*	0.040**	-0.016***	-0.000	0.016***	-0.003
Monetary policy shock, sum Q(-9,-12)	-0.024*	0.061***	-0.004	0.004	0.012***	0.003
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	55,410	4,311	16,465	59,578	16,776	19,096
Adjusted R^2	0.00	0.01	0.01	0.00	0.00	0.01
Cum. effect (in pp) of 25 bp cut	1.76**	-1.01***	1.29***	-0.06	-0.32***	0.44**

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions. The regressions exclude periods from Q3, 2014 onward for the euro area (as the ECB deposit facility rate became negative in Q2, 2014) and from Q1, 2015 onward for Switzerland (as the SNB sight deposit rate became negative in Q4, 2014).

A.2.5 Additional lags

Table 22: The effect of monetary policy shocks on housing tenure transitions with additional lags

	Renter to owner						Owner to renter					
	Germany		Italy		Switzerland		Germany		Italy		Switzerland	
Monetary policy shock, sum Q(-1,-4)	-0.017	-0.024	-0.021**	-0.024**	-0.035***	-0.043***	-0.001	0.003	-0.003	-0.003*	-0.015***	-0.012***
Monetary policy shock, sum Q(-5,-8)	-0.043**	-0.053***	0.062**	0.104***	-0.021***	-0.038***	0.001	0.005	0.008	0.011*	-0.001	0.005
Monetary policy shock, sum Q(-9,-12)	-0.034**	-0.042**	0.068***	0.070***	-0.004**	-0.034**	-0.001	0.005	0.007**	0.008***	0.001	0.011
Monetary policy shock, sum Q(-13,-16)		-0.012		0.062***		-0.028*		0.008		0.005*		0.009*
Monetary policy shock, sum Q(-17,-20)		-0.023				-0.033*		-0.004				0.013*
Monetary policy shock, sum Q(-21,-24)		-0.006				-0.050*		-0.006				0.014
Age controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Year dummies	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Linear trend	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No
Observations	53,574	53,574	5,026	5,026	18,259	18,259	56,688	56,688	19,775	19,775	21,983	21,983
Adjusted R^2	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Cum. effect (in pp) of 25 bp cut	2.35**	4.00**	-1.36**	-2.65***	1.51***	5.64**	0.03	-0.27	-0.15*	-0.26**	0.36**	-1.01

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table shows the results of tenure transition regressions with additional lags. For Italy, the available degrees of freedom do not allow to include more than one additional lag. For Germany and Switzerland, the available sample shortens starting with the year 2006. For Italy, the available sample shortens starting with the year 2003. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

A.2.6 Additional household controls

Table 23: The effect of monetary policy shocks on housing tenure transitions with additional controls

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.015	-0.021***	-0.029***	0.002	-0.004	-0.018***
Monetary policy shock, sum Q(-5,-8)	-0.028**	0.051**	-0.013***	0.001	0.009	-0.008***
Monetary policy shock, sum Q(-9,-12)	-0.025**	0.068***	-0.002	0.003	0.008**	0.000
Household controls†	Yes	Yes	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	67,431	5,677	21,039	71,251	22,219	24,777
Adjusted R^2	0.02	0.02	0.02	0.01	0.02	0.02
Cum. effect (in pp) of 25 bp cut	1.70**	-1.21***	1.10***	-0.13	-0.17	0.66***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions. † Household controls include household size, employment status, civil status, relationship status, gender, domestic nationality and real household income. Household income is gross for Germany and Switterland and net for Italy.

A.2.7 Non-linear probability models for housing tenure

Table 24: Different specifications for the effect of monetary policy shocks on housing tenure transitions

	Renter to owner						Owner to renter					
	Probit			Logit			Probit			Logit		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.013	-0.024***	-0.027***	-0.014	-0.023***	-0.026***	0.003	-0.003**	-0.015***	0.002	-0.003**	-0.014***
Monetary policy shock, sum Q(-5,-8)	-0.022*	0.059**	-0.012***	-0.022*	0.056**	-0.011***	0.003	0.007	-0.002	0.002	0.007	-0.002
Monetary policy shock, sum Q(-9,-12)	-0.022*	0.070***	0.000	-0.021*	0.069***	0.001	0.003	0.007***	0.002	0.003	0.007***	0.003
Age controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
Observations	67,431	5,677	21,039	67,431	5,677	21,039	71,251	22,219	24,777	71,251	22,219	24,777

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The reported coefficients are marginal effects (and are hence comparable across specifications), computed at the mean. For the computation of the marginal effects in the logit and probit specifications, we set the monetary policy shocks to zero - which is the approximate value of the shocks' mean.

A.2.8 Asymmetric effect of positive or negative interest rate shocks?

Table 25: The effect of monetary policy shocks on housing tenure transitions distinguishing positive and negative shocks

	Renter to owner			Owner to renter		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland
Monetary policy shock, sum Q(-1,-4)	-0.038**	0.047***	-0.066	0.014**	-0.003***	-0.073
Monetary policy shock, sum Q(-5,-8)	-0.038*	0.198***	-0.172	-0.003	0.006***	0.121
Monetary policy shock, sum Q(-9,-12)	-0.048**	0.092***	0.039	0.008	0.025***	-0.056
Monetary policy shock, sum Q(-1,-4) × Negative shock	0.036	-0.088***	0.037	-0.030***	-0.001	0.057
Monetary policy shock, sum Q(-5,-8) × Negative shock	0.020	-0.240***	0.161	-0.001	-0.013***	-0.130
Monetary policy shock, sum Q(-9,-12) × Negative shock	0.054**	-0.001	-0.049	-0.021**	-0.023***	0.065
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	67,431	5,677	21,039	71,251	22,219	24,777
Adjusted R^2	0.00	0.01	0.01	0.00	0.00	0.00
Cum. effect (in pp) of 25 bp decrease	0.30	-0.11***	1.23***	0.82*	0.12***	0.38
Cum. effect (in pp) of 25 bp increase	-3.03**	4.23***	-4.96	0.48	0.35***	-0.18

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions. Note that the cumulative effect of a 25 bp change can be significant although the individual coefficients are not significant because of the covariance of the estimates.

A.2.9 Distinguishing types of monetary policy shocks

Table 26: The effect of monetary policy shocks when conditioning the shocks on stock market movements

	Renter to owner						Owner to renter					
	Germany		Italy		Switzerland		Germany		Italy		Switzerland	
	Interest	News	Interest	News	Interest	News	Interest	News	Interest	News	Interest	News
Monetary policy shock, sum Q(-1,-4)	-0.057**	0.000	0.059*	-0.012*	-0.037***	-0.101***	-0.010	0.009	0.002	-0.001	-0.025***	-0.043***
Monetary policy shock, sum Q(-5,-8)	0.010	-0.022	0.007	0.000	-0.019*	-0.053***	-0.034***	0.016**	-0.003	0.001	-0.007	-0.006
Monetary policy shock, sum Q(-9,-12)	-0.050**	-0.010	-0.047	0.030	-0.002	-0.021**	-0.008	0.008	0.001	0.002***	0.007	-0.004
Age controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Year dummies	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Linear trend	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No
Observations	67,431	67,431	5,677	5,677	21,039	21,039	71,251	71,251	22,219	22,219	24,777	24,777
Adjusted R^2	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Cum. effect (in pp) of 25 bp cut	2.45*	0.78	-0.25	-0.23	1.47***	4.38***	1.29***	-0.82**	0.01	-0.03	0.63*	1.33***

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table shows the results of separate regressions using either interest shocks or news shocks. Interest shocks are all baseline monetary policy shocks that have the opposite sign as the return of respective the stock market index (EURO STOXX 50/SMI) on the announcement date. The remaining baseline shocks are called news shocks. The dependent variable is 1 if a household changed tenure status and 0 if it does not. Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those for Germany and Switzerland based on annual transitions.

A.3 Robustness of response of rents and house prices

Table 27: The effect of monetary policy shocks on rents: Germany, by landlord type

	(1) All landlord types All years	(2) All landlord types Years from 2013	(3) Private companies Years from 2013	(4) Private owner Years from 2013	(5) Cooperative Years from 2013	(6) Public Years from 2013
Monetary policy shock, sum Q(-1,-4)	-0.0542	0.271	0.451	0.370	1.066**	-0.582
	(-1.14)	(0.84)	(0.80)	(0.99)	(2.83)	(-0.69)
Monetary policy shock, sum Q(-5,-8)	-0.0747	0.233	0.412	0.231	0.594*	-0.0637
	(-1.06)	(0.84)	(0.87)	(0.72)	(1.87)	(-0.09)
Monetary policy shock, sum Q(-9,-12)	-0.117*	-0.0102	-0.146	-0.0184	0.194	-0.168
	(-1.74)	(-0.08)	(-0.71)	(-0.13)	(1.44)	(-0.56)
Age	Yes	Yes	Yes	Yes	Yes	Yes
Age squared	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	70189	21138	2099	12309	3942	1915
Adjusted R^2	0.01	0.02	0.04	0.03	0.04	0.03
Cum. effect (in percent) of 25 bp cut	6.15*	-12.35	-17.92	-14.56	-46.37**	20.34

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the log of real annual rent expenditures converted to adult-equivalent units using the equivalent scale detailed in Appendix A.5. Standard errors are clustered by quarter of the interview because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

Column 2 of Table 27 shows that a cut of the interest rate reduces rents in Germany in the sample period since 2013, in which the SOEP contains information the landlord type. Hence, the pass-through has become qualitatively more similar to Switzerland compared to our benchmark period (see Table 10, column 3). Some of the effects reported in Table 27 are large. The effects in columns 3, 4 and 5 would be smaller (in absolute terms), and they are thus less robust than the effect on rents for public housing in column 6, if we used shocks to yields of five-year government bonds in the regression instead of the interest rate shocks. Column 6 of Table 27 shows that the pass-through to rents seems to differ for public housing.

We check robustness of the results reported in Table 10 if we use the time windows for constructing monetary policy shocks as in Corsetti et al. (2020) or Nakamura and Steinsson (2018). The net effect on rents for Italy, reported in the bottom row of Table 28, column 2, changes sign but is still imprecisely estimated. Otherwise, the results in Table 28 and Table 29 are similar to our benchmark results reported in Table 10, Section 7.

Finally, Table 30 shows that the results, reported in Table 10 in the main text, are robust if we use shocks to the yields of five-year government bonds instead of policy rate shocks. The exception is again the effect on rents in Italy which changes sign but it is not precisely estimated.

Table 28: The effect of monetary policy shocks on rents and house prices, using the time window as in Corsetti et al. (2020) for constructing the shocks

	Rents			Housing value / House price		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland†
Monetary policy shock, sum Q(-1,-4)	-0.094**	-0.336	0.136***	0.032	-0.993	-0.024
Monetary policy shock, sum Q(-5,-8)	-0.069	-0.200*	0.064**	-0.048	-0.803***	-0.027
Monetary policy shock, sum Q(-9,-12)	-0.128	0.223	0.012	-0.228***	0.812	-0.003
Age controls	Yes	Yes	Yes	Yes	Yes	-
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	70,189	12,152	22,918	4,135	42,953	60
Adjusted R^2	0.01	0.02	0.02	0.02	0.04	1.00
Cum. effect (in percent) of 25 bp cut	7.30	7.83	-4.69**	6.10	24.58	1.36

Notes: † Aggregate, quarterly data for Switzerland because no available household-level data. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable in columns 1 to 3 is the log of real annual rent expenditures converted to adult-equivalent units using the equivalent scale detailed in Appendix A.5. The dependent variable in columns 4 and 5 is the log of the deflated house price (2010 euros). The dependent variable in column 6 is the price index for flats in Switzerland retrieved from the BIS (Property prices statistics, reference *Q:CH:0:8:0:2:0:0*). Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

Table 29: The effect of monetary policy shocks on rents and house prices in Switzerland, using the time window as in Nakamura and Steinsson (2018) for constructing the shocks

	Rent		House price†	
	Baseline	Nakamura and Steinsson (2018)	Baseline	Nakamura and Steinsson (2018)
Monetary policy shock, sum Q(-1,-4)	0.090***	0.126***	-0.021	-0.010
Monetary policy shock, sum Q(-5,-8)	0.050**	0.037	-0.024**	-0.015
Monetary policy shock, sum Q(-9,-12)	-0.000	-0.022	-0.009	0.001
Age	Yes	Yes	-	-
Age squared	Yes	Yes	-	-
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	22,918	22,918	60	60
Adjusted R^2	0.02	0.02	0.99	1.00
Cum. effect (in percent) of 25 bp cut	-3.50***	-3.51**	1.36*	0.60

Notes: † Aggregate, quarterly data for Switzerland because no available household-level data on house prices. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable in columns 1 and 2 is the log of real annual rent expenditures converted to adult-equivalent units using the equivalent scale detailed in Appendix A.5. The dependent variable in columns 3 and 4 is the price index for flats in Switzerland retrieved from the BIS (Property prices statistics, reference *Q:CH:0:8:0:2:0:0*). Standard errors are clustered by quarter of the interview because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

A.4 Robustness of results across Italian regions

We show that the results reported in the main text are robust if we use different time windows for constructing monetary policy shocks as in Corsetti et al. (2020), and if we vary the cut-off for classifying Italian regions as financially developed. In Table 34 we find that the coefficient of the interest rate shocks, with a lag between one and two years, increases for the transition from rental to owning if we add Umbria to the group of less developed regions. This changes the net effect of the shocks over all lags reported in the bottom row. The immediate effect within a year, which is most precisely estimated, remains quantitatively similar however. See Table 37 in the data appendix A.5 for the classification of Italian regions in terms of their financial development based on the indicator provided by Guiso et al. (2004).

Table 30: The effect of monetary policy shocks on rents and house prices, using five-year bond yield changes on announcement dates

	Rents			Housing value / House price		
	Germany	Italy	Switzerland	Germany	Italy	Switzerland†
5y yield change on announcement date, sum Q(-1,-4)	-0.083	-0.005	0.149***	0.022	-0.455***	-0.045*
5y yield change on announcement date, sum Q(-5,-8)	-0.053	0.032	0.067**	-0.034	0.209**	-0.051**
5y yield change on announcement date, sum Q(-9,-12)	-0.074	-0.164*	-0.000	-0.036	-0.027	-0.032**
Age controls	Yes	Yes	Yes	Yes	Yes	-
Quarter dummies	Yes	No	Yes	Yes	No	Yes
Year dummies	Yes	No	Yes	Yes	No	Yes
Linear trend	No	Yes	No	No	Yes	No
Observations	70,189	12,152	22'918	4,135	42,953	60
Adjusted R^2	0.01	0.02	0.02	0.02	0.03	1.00
Cum. effect (in percent) of 25 bp cut	5.23	3.42	-5.39***	1.19	6.80	3.21**

Notes: † Aggregate, quarterly data for Switzerland because no available household-level data. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable in columns 1 to 3 is the log of real annual rent expenditures converted to adult-equivalent units using the equivalent scale detailed in Appendix A.5. The dependent variable in columns 4 and 5 is the log of the deflated house price (2010 euros). The dependent variable in column 6 is the price index for flats in Switzerland retrieved from the BIS (Property prices statistics, reference *Q:CH:0:8:0:2:0:0*). Standard errors are clustered by quarter of the interview for Germany and Switzerland and by year for Italy, because the monetary policy shock does not vary at the household level. Age controls include age and age squared and refer to the household's reference person. The cumulative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25.

Table 31: Regression results for regional effects in Italy, using the time window as in Corsetti et al. (2020) for constructing the shocks

	Renter to owner	Owner to renter	Rents	House prices	Mortgage rate
Monetary policy shock, sum Q(-1:-4) × Developed	-0.406***	0.013	0.373	0.291**	-0.296
Monetary policy shock, sum Q(-5:-8) × Developed	-0.100**	-0.014	-0.028	0.241***	0.099
Monetary policy shock, sum Q(-9:-12) × Developed	0.363***	-0.070**	0.654*	0.496***	0.891
Developed dummy	-0.029***	0.001	0.476***	0.160***	-0.432**
Age controls	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	5,645	22,142	12,085	42,765	2,493
Adjusted R^2	0.01	0.00	0.12	0.06	0.18
Cum. relative effect of 25 bp cut	1.78* pp	0.88** pp	-24.97*** percent	-25.71*** percent	-0.17 pp

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not for the tenure transition regressions. Real annual rent expenditures are logs of rents in 2010 euro converted into adult equivalents for each household, real house price are logs of prices in 2010 euro, and the variable-rate mortgage rate is in percent. Standard errors are clustered by year. Age controls include age and age squared and refer to the household's reference person. The cumulative relative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those based on annual transitions.

Table 32: Regression results for regional effects in Italy using 5-year bond yield changes on announcement dates

	Renter to owner	Owner to renter	Rents	House prices	Mortgage rate
5y yield change on announcement date, sum Q(-1:-4) × Developed	-0.138***	-0.002	0.124	0.122	0.963*
5y yield change on announcement date, sum Q(-5:-8) × Developed	0.042**	0.005	-0.134**	-0.084	-0.563***
5y yield change on announcement date, sum Q(-9:-12) × Developed	-0.047	-0.009	0.061	-0.025	0.764
Developed dummy	-0.031***	-0.003	0.542***	0.203***	-0.329***
Age controls	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	5,645	22,142	12,085	42,765	2,493
Adjusted R^2	0.01	0.00	0.12	0.06	0.18
Cum. relative effect of 25 bp cut	1.78** pp	0.08 pp	-1.26 percent	-0.33 percent	-0.29 pp

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not for the tenure transition regressions. Real annual rent expenditures are logs of rents in 2010 euro converted into adult equivalents for each household, real house price are logs of prices in 2010 euro, and the variable-rate mortgage rate is in percent. Standard errors are clustered by year. Age controls include age and age squared and refer to the household's reference person. The cumulative relative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those based on annual transitions.

Table 33: Regression results for regional effects in Italy with Sardinia in developed group

	Renter to owner	Owner to renter	Rents	House prices	Mortgage rate
Monetary policy shock, sum Q(-1:-4) × Developed	-0.034**	-0.002	-0.103***	0.025	0.275
Monetary policy shock, sum Q(-5:-8) × Developed	0.017	-0.006	0.356***	0.143	0.977**
Monetary policy shock, sum Q(-9:-12) × Developed	-0.032	-0.006	0.245***	0.096	0.020
Developed dummy	-0.029***	-0.004*	0.461***	0.143***	-0.357***
Age controls	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	5,645	22,142	12,085	42,765	2,493
Adjusted R^2	0.01	0.00	0.10	0.05	0.18
Cum. relative effect of 25 bp cut	0.61 pp	0.17 pp	-12.46*** percent	-6.58 percent	-0.32* pp

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not for the tenure transition regressions. Real annual rent expenditures are logs of rents in 2010 euro converted into adult equivalents for each household, real house price are logs of prices in 2010 euro, and the variable-rate mortgage rate is in percent. Standard errors are clustered by year. Age controls include age and age squared and refer to the household's reference person. The cumulative relative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those based on annual transitions.

Table 34: Regression results for regional effects in Italy with Umbria in less developed group

	Renter to owner	Owner to renter	Rents	House prices	Mortgage rate
Monetary policy shock, sum Q(-1:-4) × Developed	-0.068***	-0.004	-0.075**	0.034	0.395**
Monetary policy shock, sum Q(-5:-8) × Developed	0.093*	-0.002	0.368***	0.111	0.427
Monetary policy shock, sum Q(-9:-12) × Developed	-0.009	-0.003	0.206***	0.110	0.171
Developed dummy	-0.022***	-0.000	0.532***	0.200***	-0.400***
Age controls	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	5,645	22,142	12,085	42,765	2,493
Adjusted R^2	0.01	0.00	0.12	0.06	0.18
Cum. effect of 25 bp cut	-0.19 pp	0.12 pp	-12.47*** percent	-6.37 percent	-0.25 pp

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is 1 if a household changed tenure status and 0 if it does not for the tenure transition regressions. Real annual rent expenditures are logs of rents in 2010 euro converted into adult equivalents for each household, real house price are logs of prices in 2010 euro, and the variable-rate mortgage rate is in percent. Standard errors are clustered by year. Age controls include age and age squared and refer to the household's reference person. The cumulative relative effect over three years of a -25 bp shock is obtained by multiplying the sum of the coefficients with -0.25. The reported cumulative effects for Italy based on biannual transitions are adjusted to be comparable with those based on annual transitions.

A.5 Data appendix

The German Socioeconomic Panel (SOEP), the Swiss Household Panel (SHP) and the Italian Survey on Household Income and Wealth (SHIW) are unbalanced household panels. Households are interviewed once a year in the SOEP and SHP and every other year in the SHIW. The SOEP contains information on households since 1990, the SHP since 1999, and the SHIW since 1977. For all three countries, we use the data on households in the time period 2000-2016 together with the data series which we constructed for the monetary policy shocks. The summary statistics are reported for the sample period 2002-2016, which is used in our estimations because monetary policy shocks enter with lags in the estimated specifications.

For the household-level data in all three countries, our constructed sample consists of households for which the following variables were recorded: housing tenure (renter or owner), age, household size (number of people), civil status (married or not as well as in a partnership or not), working status (yes or no), the interviewee's gender, nationality and region, and household income. The SOEP and SHP provide information on household gross income, which includes labor earnings, capital income, pensions and (government) transfers. We keep households in the sample which report non-negative household income. In the SHIW, the reported net income includes transfers between households so that net income can be negative if households make a transfer. Thus, we keep the few households in the sample that report negative net income. We further keep households whose interviewee is the household head (or partner), and we focus on household heads

with an age between 25 and 84. This covers ages at which most households have finished full-time education, have entered the labor market or are retired. The constructed sample contains 138,682, 45,816 and 27,896 households, respectively, for the SOEP, the SHP and the SHIW in the sample period used for the estimations.

We now discuss for each country how we obtain information on the other variables used in the estimations. For Germany, data on rents, net worth and an approximated house price are available at the household-level in the SOEP. Households report rent expenditure (annualized and net of utility expenditure) and net worth (total wealth net of debt). We approximate house prices using the (annualized) mortgage expenditure reported in the data. This expenditure contains both amortization and interest payments, which cannot be distinguished in the data. We approximate house prices for households who moved into their current property in the previous two years because these households are less likely to have altered their initial mortgage contract, and the purchase price of their home reflects current economic conditions. We assume mortgage amortization over a typical 25-year period and a loan-to-value ratio of 50%, which corresponds to the average loan-to-value ratio of German mortgagors, aged 36-45 and thus with relatively new mortgages, in the 2014 wave of the Household Finance and Consumption Survey (HFCS). We further use the mortgage rate for the year in which the household moved in. Specifically, we use the annualized agreed mortgage rate for Germany provided by the ECB (key: *124.MIR.M.DE.B.A2C.AM.R.A.2250.EUR.N*), which is the agreed interest rate for new mortgages to the household sector.

We assume constant mortgage payments over time as in the typical mortgage contract observed in Germany.[33] Because mortgage payments consist of amortization and interest payments, the amortization payment A_t of a household, for a mortgage D_t in period t and a fixed mortgage interest rate i, is given by:

$$A_t = \left(\frac{1}{(1+i)^{t+1} - 1} \right) D_t \, . \tag{A.1}$$

The mortgage changes over time due to amortization: $D_{t+1} = D_t - A_t$. The interest payment is iD_t, and the share of mortgage payments used for servicing the interest is $s_t = \frac{iD_t}{A_t + iD_t}$. The amortization rate is defined as $a_t = \frac{A_t}{D_t}$ so that $D_{t+1} = D_t(1 - a_t)$.

We use the mortgage payments reported by a household in the SOEP, multiplied by the share s_t, to retrieve the interest payment at the household level, and we obtain the current mortgage value by dividing this interest payment by the mortgage interest rate. We then back out the initial mortgage value at purchase by adding the amortization pay-

[33] The estimation results based on the approximated house prices are unchanged if we assume linear amortization.

ments to the current mortgage value. We divide the current mortgage value by $(1 - a_t)$ for households who moved in last year, and by $(1 - a_t)(1 - a_{t-1})$ for households who moved in two years ago. Dividing the initial mortgage value by the loan-to-value ratio of 50%, we obtain the approximated house value. The average (median) approximated house value amounts to EUR 206,293 (178,620) and is thus in the ballpark of the values reported by households in the Household Finance and Consumption Survey (HFCS) for Germany in 2014. Given that we need information on house values before and after the monetary policy shocks, we cannot use the survey information on house values in the HFCS directly for our analysis because that survey has been conducted only every three years since 2010.

For Switzerland, we do not have household-level measures on house values and net worth. We also do not know which households are new homeowners in the Swiss household budget survey (*Haushaltsbudgeterhebung* or HABE), which contains information on mortgage expenditures, so that we cannot apply the approximation of house prices discussed for the SOEP above. Thus, as mentioned in the main text, we use aggregate-level house prices for Switzerland. For expenditures on housing rents, we use household-level data from the HABE. The HABE is a repeated cross-sectional data set. It contains data on detailed household income and expenditure items between 2000Q1 and 2017Q4 and is used for the national CPI calculations. We construct the sample for the HABE, proceeding analogously as before for the SOEP, SHP and SHIW, by keeping households whose interviewee is the reference person (the household head) and is aged between 25 and 84. We further keep households which report positive gross income, mandatory payments (which include taxes and mandatory health insurance), disposable income (income minus mandatory payments), consumption expenditure and rent. To contain the effect of potential outliers, we trim the sample by keeping households which report a gross saving rate (measured as disposable income minus expenditure, divided by disposable income) between the first and 99th percentiles in a given interview year. The final sample used for the estimation contains 22,918 renters.

For Italy, the information on house prices is based on the self-reported house value provided by households in the SHIW. Specifically, households are asked: "In your opinion, how much is your house/flat worth (unoccupied)? In other words, what price could you ask for it today (including any cellar, garage or attic)? Please give your best estimate." For rents, we use reported annual rent payments. In order to identify households, who have not moved between survey years, we restrict the sample to those renters who provide the same construction year of their flat/house for consecutive survey years. For net worth, we use the definition provided in the SHIW, which is the value of real assets plus the value of financial assets minus the value of financial liabilities. The median net worth for each transition group is reported in Table 6, and the median net worth for each of these groups

by region is shown in Table 38.

For all three considered countries, we convert the series for rental expenditures to adult-equivalent units by using the equivalent scale of Fernandez-Villaverde and Krueger (2007) in Table 1, column 7 (p. 554). For households with more than five persons, the scale is increased by 0.3 per additional person which equals the increment for the fifth person in Fernandez-Villaverde and Krueger (2007). When indicated, the series are deflated by using the annual nationwide CPI with 2010 as the base year. For Germany and Switzerland we use the series with the FRED codes *DEUCPIALLMINMEI* and *CHECPIALLMINMEI*, respectively. For Italy, we use the consumption deflator provided in the SHIW from Istat.

In Tables 35 to 39 we provide further descriptive evidence. Tables 35 and 36 show that some household characteristics are different across language groups in Switzerland, whether we classify language groups using information on both the reported mother tongue and the location of residence in Table 35, or using only information on the reported mother tongue in Table 36. For instance, Italian-speaking households have lower income across all housing tenure groups. Given these differences, we control for income as well as some other household characteristics, when we analyze the effect of interest rate shocks on housing tenure transitions across Swiss language groups in Section 6.

Table 37 shows how we classify Italian regions in terms of their financial development based on the indicator provided by Guiso et al. (2004). We use the binary classification to construct the spread in the mortgage rates between regions that are more and less financially developed. In Tables 33 and 34 in Appendix A.2, we provide robustness checks if we assign the marginal regions, Umbria or Sardinia, to the respective other category.

Table 38 provides summary statistics for the subpopulations that change, or do not change, housing tenure status in the Italian regions with a different degree of financial development. Table 38 shows that the differences across the subpopulations discussed in the main text for Table 6, Section 5, also hold for the two types of Italian regions. The minor differences in the total sample size compared to Table 6 result from some households that we drop because they change region type.

Table 39 shows how key characteristics in the housing and mortgage market differ across Italian regions with different financial development.

Table 35: Summary statistics for housing-tenure groups in Switzerland, across language groups

	Swiss-German			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	14,447	615	18,779	301
Age (household head)	50.2	45.6	56.0	55.1
Household size (persons)	2.2	2.8	2.8	2.1
In a couple (%)	53.4	77.7	80.0	53.5
Married (%)	40.9	59.8	75.3	44.5
Working (%)	71.3	79.8	67.2	64.1
Gender (% male)	37.7	37.6	40.6	39.9
Domestic citizenship (%)	90.9	91.2	95.5	97.3
Gross household income (2010 CHF, annual)	94,068	128,563	122,211	98,664
	German			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	524	17	439	13
Age (household head)	50.8	44.8	57.0	62.5
Household size (persons)	2.1	2.6	2.7	1.6
In a couple (%)	55.5	58.8	80.2	53.8
Married (%)	38.5	58.8	75.9	30.8
Working (%)	71.4	82.4	61.5	30.8
Gender (% male)	39.1	29.4	44.6	30.8
Domestic citizenship (%)	57.8	76.5	66.7	92.3
Gross household income (2010 CHF, annual)	108,641	146,193	130,578	66,937
	French			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	4,459	151	4,116	75
Age (household head)	51.3	43.8	55.3	53.6
Household size (persons)	2.3	3.0	2.8	2.3
In a couple (%)	54.0	83.4	80.8	53.3
Married (%)	44.0	69.5	77.3	44.0
Working (%)	64.0	83.4	63.6	66.7
Gender (% male)	33.6	39.1	36.2	30.7
Domestic citizenship (%)	85.8	90.1	91.4	92.0
Gross household income (2010 CHF, annual)	94,070	132,157	124,230	103,226
	Italian			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	789	37	1,035	19
Age (household head)	54.3	44.9	55.6	58.5
Household size (persons)	2.2	3.0	2.7	1.7
In a couple (%)	53.1	70.3	72.2	36.8
Married (%)	48.3	56.8	70.0	31.6
Working (%)	51.0	70.3	53.5	47.4
Gender (% male)	36.9	29.7	35.6	47.4
Domestic citizenship (%)	70.5	75.7	81.0	84.2
Gross household income (2010 CHF, annual)	72,362	92,386	97,363	64,813

Source: SHP. *Notes:* Averages for households interviewed between 2002-2016. Medians for income measures. Changes in tenure refer to changes since the last survey. Real incomes are deflated by the national CPI. 19,474 out of 45,816 households report their main language. For the other households, we assign the language based on the location in which the household lives.

Table 36: Summary statistics for housing-tenure groups in Switzerland, across groups of reported mother tongue

	Swiss-German			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	4'153	163	5'976	91
Age (household head)	52.9	46.3	56.4	57.3
Household size (persons)	2.1	2.7	2.7	2.1
In a couple (%)	52.8	79.1	78.8	50.6
Married (%)	44.6	62.6	74.5	49.5
Working (%)	69.1	76.1	67.6	54.9
Gender (% male)	39.5	39.3	45.1	42.9
Domestic citizenship (%)	95.5	95.7	98.2	100.0
Gross household income (2010 CHF, annual)	94'355	123'357	123'330	96'774

	German			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	524	17	439	13
Age (household head)	50.8	44.8	57.0	62.5
Household size (persons)	2.1	2.6	2.7	1.6
In a couple (%)	55.5	58.8	80.2	53.8
Married (%)	38.5	58.8	75.9	30.8
Working (%)	71.4	82.4	61.5	30.8
Gender (% male)	39.1	29.4	44.6	30.8
Domestic citizenship (%)	57.8	76.5	66.7	92.3
Gross household income (2010 CHF, annual)	108'641	146'193	130'578	66'937

	French			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	1'519	62	1'738	37
Age (household head)	51.5	44.4	54.7	53.7
Household size (persons)	2.2	3.0	2.8	2.2
In a couple (%)	50.4	75.8	83.8	48.6
Married (%)	40.5	66.1	79.9	45.9
Working (%)	65.7	77.4	66.5	70.3
Gender (% male)	35.9	37.1	41.0	32.4
Domestic citizenship (%)	87.9	88.7	94.0	94.6
Gross household income (2010 CHF, annual)	96'187	121'153	122'069	105'527

	Italian			
	Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter
Observations	332	16	361	8
Age (household head)	56.2	45.7	57.6	55.4
Household size (persons)	2.1	2.8	2.6	2.0
In a couple (%)	50.0	75.0	80.1	37.5
Married (%)	42.5	56.3	81.7	37.5
Working (%)	45.2	62.5	53.7	62.5
Gender (% male)	40.1	37.5	42.9	37.5
Domestic citizenship (%)	53.3	75.0	78.4	75.0
Gross household income (2010 CHF, annual)	70'599	111'806	95'714	88'085

Source: SHP. *Notes:* Averages for households interviewed between 2002-2016. Medians for income measures. Changes in tenure refer to changes since the last survey. Real incomes are deflated by the national CPI. The sample consists of 19,474 (out of 45,816) households that report their main language. The descriptive statistics for German speakers coincide with those in the previous table by construction because the location of residence in Switzerland implies assignments only to the other three language groups.

Table 37: Regional split for Italy based on the normalized measure of financial development in Guiso et al. (2004), table 2.

Region	Measure of financial development	Classification
Marche	0.59	
Liguria	0.59	
Emilia - Romagna	0.52	
Veneto	0.52	
Piedmont	0.47	Developed
Trentino - Alto Adige	0.46	
Lombardy	0.44	
Friuli - Venezia Giulia	0.41	
Umbria	0.40	
Sardinia	0.37	
Tuscany	0.36	
Abruzzo	0.36	
Basilicata	0.35	
Molise	0.25	
Sicily	0.21	Less developed
Apulia	0.17	
Lazio	0.07	
Campania	0.03	
Calabria	0.00	

Table 38: Summary statistics for housing-tenure groups across Italian regions

	Developed				Less developed			
	Renters		Owners		Renters		Owners	
	Remained renter	Became owner	Remained owner	Became renter	Remained renter	Became owner	Remained owner	Became renter
Observations	2,756	219	11,746	155	2,417	253	10,084	157
Age (household head)	55.1	54.1	60.3	57.1	56.6	54.4	60.4	56.4
Household size (persons)	2.3	2.2	2.5	1.9	2.8	2.7	2.7	2.0
In a couple (%)	52.2	51.1	70.9	36.8	63.4	64.4	70.7	41.4
Married (%)	51.9	48.9	70.2	36.1	62.0	63.2	70.3	39.5
Working (%)	53.3	58.4	41.3	49.0	35.9	47.0	36.7	47.1
Gender (% male)	53.9	55.3	63.0	53.5	51.2	60.1	58.1	50.3
Birth region domestic (%)	81.4	91.3	97.5	89.7	93.9	96.8	98.9	98.1
Net household income (2010 EUR, annual)	19,098	30,818	36,191	16,954	14,920	22,235	27,374	15,600
Net worth (2010 EUR)	6,616	178,652	256,141	8,230	2,941	144,584	202,317	3,197

Sources: SHIW (Italy). *Notes:* Averages for households interviewed between 2002-2016. Medians for income and net worth. Changes in tenure refer to changes since the last survey. Real incomes and net worths are deflated by the national CPI.

Table 39: Housing and mortgages across Italian regions

	Developed	Less developed
Homeownership rate (%)	78.3 (0.5)	80.7 (0.5)
Incidence of mortgagors (as % owners)	17.5 (0.5)	14.2 (0.5)
Incidence of mortgagors (as % new owners)	23.1 (6.8)	16.1 (5.0)
Flexible rate mortgagors (as % of mortagors)	38.6 (1.4)	22.0 (1.3)

Sources: SHIW. *Notes:* Standard errors in parentheses. The statistics are based on the representative sample years 2014/2016 to be comparable with the aggregate statistics in Table 1 in the main text. New owners are renters who became owners between the last and the current survey wave.

A.6 Annualization of the biannual transition probabilities for Italy

For completeness, we discuss how we obtain the annual transition probabilities based on information on the biannual transition probabilities. We denote the annual transition matrix by $\mathbf{T_1}$ and the biannual transition matrix by $\mathbf{T_2}$ with

$$\mathbf{T_1} = \begin{array}{c} \\ \text{Renter} \\ \text{Owner} \end{array} \begin{array}{c} \begin{array}{cc} \text{Renter} & \text{Owner} \end{array} \\ \begin{pmatrix} (1-p) & p \\ q & (1-q) \end{pmatrix} \end{array}, \quad \mathbf{T_2} = \begin{array}{c} \\ \text{Renter} \\ \text{Owner} \end{array} \begin{array}{c} \begin{array}{cc} \text{Renter} & \text{Owner} \end{array} \\ \begin{pmatrix} (1-P) & P \\ Q & (1-Q) \end{pmatrix} \end{array}.$$

Observing that

$$\mathbf{T_2} = \mathbf{T_1}^2 = \begin{pmatrix} (1-p)(1-p)+pq & (1-p)p+p(1-q) \\ q(1-p)+(1-q)q & qp+(1-q)(1-q) \end{pmatrix},$$

we obtain a system of two equations which maps the annual transition probabilities p and q into the corresponding biannual transition probabilities P and Q:

$$P = (1-p)p + p(1-q), \tag{A.2}$$

$$Q = (1-q)q + q(1-p). \tag{A.3}$$

The probabilities $1-P$, $1-Q$, $1-p$ and $1-q$ result from the property that probabilities in each row of the transition matrices have to sum to one.

Solving equations (A.2) and (A.3) for p and q, respectively, we obtain

$$p = \frac{2-q}{2} - \sqrt{\frac{(2-q)^2}{4} - P}, \tag{A.4}$$

$$q = \frac{2-p}{2} - \sqrt{\frac{(2-p)^2}{4} - Q}, \tag{A.5}$$

where we only consider the sign of the root for which $0 \leq p \leq 1$ and $0 \leq q \leq 1$.

For annual transitions across housing tenure states that are small, $(2-x)/2 \approx 1$ for $x = p, q$, and we obtain the closed form solutions

$$p \approx 1 - \sqrt{1-P}, \tag{A.6}$$

$$q \approx 1 - \sqrt{1-Q}. \tag{A.7}$$

In Figure 4 we annualize the biannual flows using equations (A.6) and (A.7), respectively. A first-order Taylor approximation of (A.6) and (A.7) implies, as usual, that

$$p \approx \frac{P}{2} \text{ and } q \approx \frac{Q}{2} \quad , \tag{A.8}$$

if biannual transition probabilities are small. We find that the approximation implies negligible approximation error in our application. We thus use (A.8) to annualize the cumulative effects of 25 bp rate cuts for the housing-tenure regressions in Italy.

Recent SNB Working Papers

2021-06 Winfried Koeniger, Benedikt Lennartz, Marc-Antoine Ramelet: On the transmission of monetary policy to the housing market

2021-05 Romain Baeriswyl, Lucas Fuhrer, Petra Gerlach-Kristen, Jörn Tenhofen: The dynamics of bank rates in a negative-rate environment – the Swiss case

2021-04 Robert Oleschak: Financial inclusion, technology and their impacts on monetary and fiscal policy: theory and evidence

2021-03 David Chaum, Christian Grothoff, Thomas Moser: How to issue a central bank digital currency

2021-02 Jens H.E. Christensen, Nikola Mirkov: The safety premium of safe assets

2021-01 Till Ebner, Thomas Nellen, Jörn Tenhofen: The rise of digital watchers

2020-25 Lucas Marc Fuhrer, Marc-Antoine Ramelet, Jörn Tenhofen: Firms' participation in the COVID-19 loan programme

2020-24 Basil Guggenheim, Sébastien Kraenzlin, Christoph Meyer: (In)Efficiencies of current financial market infrastructures – a call for DLT?

2020-23 Miriam Koomen, Laurence Wicht: Demographics, pension systems, and the current account: an empirical assessment using the IMF current account model

2020-22 Yannic Stucki, Jacqueline Thomet: A neoclassical perspective on Switzerland's 1990s stagnation

2020-21 Fabian Fink, Lukas Frei, Oliver Gloede: Short-term determinants of bilateral exchange rates: A decomposition model for the Swiss franc

2020-20 Laurence Wicht: A multi-sector analysis of Switzerland's gains from trade

2020-19 Terhi Jokipii, Reto Nyffeler, Stéphane Riederer: Exploring BIS credit-to-GDP gap critiques: the Swiss case

2020-18 Enzo Rossi, Vincent Wolff: Spillovers to exchange rates from monetary and macroeconomic communications events

2020-17 In Do Hwang, Thomas Lustenberger, Enzo Rossi: Does communication influence executives' opinion of central bank policy?

2020-16 Peter Kugler, Samuel Reynard: Money, inflation and the financial crisis: the case of Switzerland

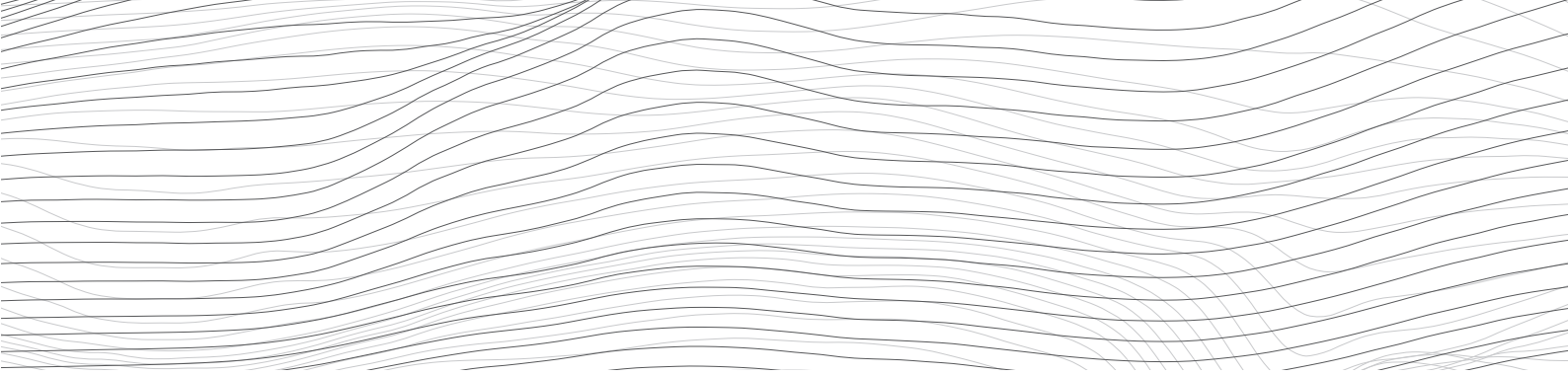
2020-15 Sébastien Kraenzlin, Christoph Meyer, Thomas Nellen: COVID-19 and regional shifts in Swiss retail payments

2020-14 Christian Grisse: Lower bound uncertainty and long-term interest rates

2020-13 Angela Abbate, Sandra Eickmeier, Esteban Prieto: Financial shocks and inflation dynamics

2020-12 Toni Beutler, Matthias Gubler, Simona Hauri, Sylvia Kaufmann: Bank lending in Switzerland: Capturing cross-sectional heterogeneity and asymmetry over time

2020-11 Sophie Altermatt, Simon Beyeler: Shall we twist?



SCHWEIZERISCHE NATIONALBANK
BANQUE NATIONALE SUISSE
BANCA NAZIONALE SVIZZERA
BANCA NAZIUNALA SVIZRA
SWISS NATIONAL BANK