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Winfried Koeniger and Marc-Antoine Ramelet

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Center for Financial Studies | Goethe University | Theodor-W.-Adorno-Platz 3 | 60323 Frankfurt am Main | Germany
Phone +49 69 798 30050 | Fax +49 69 798 30077 | info@ifk-cfs.de | www.ifk-cfs.de

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Home Ownership and Monetary Policy Transmission *

Winfried Koeniger[a]
(University of St.Gallen, CESifo, CFS, IZA)

Marc-Antoine Ramelet[b]
(University of St.Gallen)

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Abstract

We present empirical evidence on the heterogeneity in monetary policy transmission across countries with different home ownership rates. We use household-level data together with shocks to the policy rate identified from high-frequency data. We find that housing tenure reacts more strongly to unexpected changes in the policy rate in Germany and Switzerland –the OECD countries with the lowest home ownership rates– compared with existing evidence for the U.S. An unexpected decrease in the policy rate by 25 basis points increases the home ownership rate by 0.8 percentage points in Germany and by 0.6 percentage points in Switzerland. The response of non-housing consumption in Switzerland is less heterogeneous across renters and mortgagors, and has a different pattern across age groups than in the U.S. We discuss economic explanations for these findings and implications for monetary policy.

Keywords: Monetary policy transmission, Home ownership, Housing tenure, Consumption.

JEL-codes: E21, E52, R21.

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a: 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, marc-antoine.ramelet@unisg.ch.

1 Introduction

The transmission of monetary policy is at the core of the research agenda in economics. In the canonical New-Keynesian model with a representative agent, intertemporal substitution of consumption determines how unexpected changes in the interest rate transmit to consumption and output (Galí, 2015). A recent literature has revived the interest in alternative transmission channels of monetary policy, for example, through direct effects on cash flows or general equilibrium effects on income, or through effects on the valuation of households' balance sheet positions (e.g., Auclert, 2017, Beraja et al., 2017, Di Maggio et al., 2017, Kaplan et al., 2016 and references therein).

Asset and liability positions in balance sheets differ across households so that consumption responses of households to unexpected changes in the monetary policy rate are heterogeneous. Cloyne et al. (2017) show that this heterogeneity matters empirically because mortgagors in the U.S. and U.K. react more strongly to changes in the policy rate than renters and Wong (2018) shows that decisions to refinance mortgages after monetary policy shocks imply much stronger consumption responses of young compared to old households in the U.S.

We contribute to this literature by providing empirical evidence at the household level which shows that the transmission of monetary policy changes across countries with different homeownership rates. Home ownership drastically changes the balance sheet of households: it adds the value of the home as asset and the value of the mortgage as liability, which are the largest items on both sides of the balance sheet for the typical homeowner. Changes in the policy rate may not only change the value of these asset and liability positions, and thus affect the housing tenure decision of households, but also directly influence the mortgage interest payments which enter the budget constraint of indebted homeowners.

We estimate the response to monetary policy shocks in Germany and Switzerland and compare these responses with existing estimates for the U.S. and U.K. We choose Germany and Switzerland because these countries have the lowest home ownership rates of roughly 40% in the OECD compared with rates of approximately two thirds in the U.S. and U.K. We show that monetary policy shocks in Germany and Switzerland trigger a stronger response in the housing market than in the U.S. and the U.K.: an unexpected decrease of the policy rate by 25 basis points increases the homeownership rate by 0.8 and 0.6 percentage points in Germany and Switzerland, respectively. We show that this net effect results from changes in housing tenure that differ across age groups. Furthermore, we find that the responses of non-housing consumption to monetary policy shocks are smaller, and more similar across mortgagors and renters, in Switzerland compared with the U.S.

and the U.K.[1] An unexpected shock to the policy rate also does not impact consumption inequality in Switzerland significantly, differently to findings by Coibion et al. (2017) for the U.S.

The estimated responses are consistent with results of experiments performed in a calibrated life-cycle model with uninsurable income risk. Hintermaier and Koeniger (2018) show that an unexpected decrease in the *real* interest rate has a smaller effect on non-housing consumption if households' balance sheets are less tilted towards housing (see the top panel of table 6 in their paper). For the model calibration to Germany, they further show that the lower user cost of housing and the lower rent-to-price ratio, resulting from the fall in the real interest rate, induce a portfolio shift into owned housing for young age groups whereas the opposite is true for older age groups (see Figure 5 in Hintermaier and Koeniger, 2018).[2] We will expand on the economic intuition for these results when we discuss our empirical findings.

Our findings complement recent empirical work based on aggregate data by Calza et al. (2013) and Corsetti et al. (2018) who have shown that monetary policy transmission to aggregate consumption and house prices is heterogeneous across developed countries and within the euro area, and that this heterogeneity is associated with differences in housing markets. We analyze the transmission at the micro level using household-level data for Germany and Switzerland.[3] This allows us to uncover in more detail how differences in housing markets affect the transmission in these countries. We describe in Section 2 how housing markets differ between Germany and Switzerland and the U.S. and the U.K., the countries which we use to benchmark our findings.

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 of these expectations in a short time window around the

[1] Unfortunately, no comparable household-level data on consumption are available for Germany at an annual or quarterly frequency so that we can provide a detailed analysis of consumption responses at the household level only for Switzerland.

[2] The experiments within the calibrated model focus on the part of the monetary policy transmission from changes of the *real* interest rate to the real economy. Thus, we cannot compare the results of the experiments quantitatively with our empirical estimates. To the extent that unexpected changes in the *nominal* policy rate affect the *real* interest rate, as we show below in Table 3, it is comforting to see that the estimated responses are qualitatively consistent with the model-based experiments. The transmission of monetary policy shocks to the real interest rate may result from nominal rigidities or from a redistribution of wealth from the private to the public sector after open market operations, as pointed out by Sterk and Tenreyro (2015).

[3] Jappelli and Scognamiglio (2018) use the quasi-experimental setting of the unexpected large drop of interest rates after the Great Recession to estimate the consumption response of mortgagors in Italy, a country with a slightly higher homeownership rate than the U.S. and the U.K. but a relatively small mortgage market. They find that the type of mortgage does not affect the consumption response significantly.

monetary policy announcements. Recent applications of this approach are in Gertler and Karadi (2015) or Nakamura and Steinsson (2018) for the U.S., Gerko and Rey (2017) for the U.K., Corsetti et al. (2018) 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 and Switzerland, and we explain why these features matter for monetary policy transmission. We then discuss in Section 3 how we identify exogenous movements of the policy rate. We present the household-level data for Germany and Switzerland in Section 4, which we then use to estimate the responses of housing tenure and consumption in Sections 5 and 6, respectively. We conclude in Section 7.

2 Housing markets and monetary policy transmission

Household portfolios, and home ownership rates in particular, differ widely across countries (see, for example, Christelis et al., 2013). Table 1 shows that the differences in home-ownership rates, between Germany and Switzerland on the one hand and the U.S. and the U.K. on the other hand, have narrowed slightly in the 2000s but are very persistent.

Table 1: Home ownership rates (%)

	2000	2014	Change
UK	71	63	-8
US	67	65	-2
Germany	42	46	+4
Switzerland	35	38	+3

Sources: UK Ministry of Housing (English Housing Survey, Headline Report, Section 1, Figure 1.1), FRED (Economic Data, Series *RHORUSQ156N*), ECB (Statistical Data Warehouse, Dataset *SHI*, Key *SHI.A.DE.TOOT.P*), SFO (Federal Population Census, Table *09.03.02.01.01*). *Notes:* The table reports owner occupation rates. The value for 2000 in Germany is interpolated using data for 1998 and 2002.

Home ownership may modify monetary policy transmission to both nondurable and durable consumption because housing is less liquid than other assets: illiquidity increases the marginal propensity to consume out of transitory income shocks (Kaplan and Violante, 2014), which is a key determinant of the consumption response to changes in the interest rate (Auclert, 2017).

The extent of home ownership may also change the transmission of monetary policy in the housing market. We first discuss how monetary policy transmits to housing tenure

choice and then mention how this transmission may be modified in countries, such as Germany and Switzerland, where the home ownership rate is low for structural reasons that are unrelated to monetary policy.

After a shock to the policy rate, households will 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 size of the shock to the policy rate and its pass through to prices in the housing and mortgage market. For example, a change in the mortgage interest rate affects the user cost of owning a house and together with the response of rents and house prices may trigger changes in home ownership.[4]

As we show in Section 3, the pass through of policy rate shocks to long-term interest rates is sizable because markets expect monetary policy shocks to be fairly persistent in Germany and Switzerland, which is similar to the U.S. (Nakamura and Steinsson, 2018) and the U.K. (Gerko and Rey, 2017). A similar pass through of policy shocks to long-term interest rates may trigger different responses of housing tenure choices, however, if the subpopulation of (potential) marginal home buyers and sellers in Germany and Switzerland has different characteristics –for example in terms of age, income or saving behavior– and thus reacts differently to interest-rate changes compared to the marginal home buyers in the U.S. and the U.K.

The descriptive evidence in Andrews and Sánchez (2011a) and Andrews and Sánchez (2011b) suggests that the marginal home buyers and sellers in Germany and Switzerland are indeed different from those in the U.S. and the U.K. due to differences in tax incentives and regulation that are associated with differences in house prices (see also the references therein). Starting from a lower initial level of home ownership at a young age, the age gradient of home ownership is steeper in Germany and Switzerland until home ownership peaks at ages 55 to 64. Thus, until that peak, the net flow from rental to home ownership increases more in Germany and Switzerland than in the U.S. and the U.K. as households age. We provide further details on the flows between the types of housing tenure in Section 4.

The transmission of monetary policy is also influenced by characteristics of the mortgage market which differ considerably across countries (see Badarinza et al., 2018 and references therein). Shocks to the policy rate have a stronger effect on cash flows and

[4]The transmission of monetary policy to rents in Switzerland may be influenced by the indexation of rents to a reference mortgage rate. Until 2008, the reference rate was an average of the rates recorded by banks at the cantonal level. Since then, there is 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 these changes. To get an indication of how the cost of renting versus owning changes with the policy rate, we estimate the response of house prices, rents and mortgage interest payments to unexpected changes in the policy rate in Sections 5 and 6.

possibly also consumption if mortgagors have an adjustable-rate mortgage, or if they can refinance a fixed-rate mortgage or release home equity at low cost (Calza et al., 2013).

Table 2: Mortgage contract characteristics

	Typical mortgage rate fixation	Equity release products	Early repayment penalties on fixed-rate mortgages
UK	Adjustable	Used	Used
US	Fixed	Used	Not used
Germany	Fixed	Not used	Used
Switzerland	Fixed	Not used	Used

Sources: Compilation of information in Lea (2010) and Calza et al. (2013) on rate fixation, equity release and early repayment penalties.

Table 2 shows that typical mortgage contracts are quite different in the U.S. and the U.K. compared to Germany and Switzerland. Most households in the U.K. have mortgage contracts with an adjustable rate and they can release home equity. In the U.S. most households have fixed-rate mortgages but they can refinance their mortgage at little cost (ex post, the bank bears the cost of foregone interest if a household decides to refinance). This implies that a decrease in the mortgage interest rate reduces mortgage payments and should increase the consumption 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 of equity release are not common.[5] Becoming a new home owner may become more attractive in all countries instead if the mortgage interest rate decreases unexpectedly. Whether the transmission of the policy rate shocks to home ownership is heterogeneous across countries is an empirical question which we investigate further in Section 5.

3 Identification of monetary policy shocks

Monetary policy responds endogenously to aggregate conditions, as illustrated in panel (a) of Figure 1. For Germany, the figure plots the three key interest rates set by the Eu-

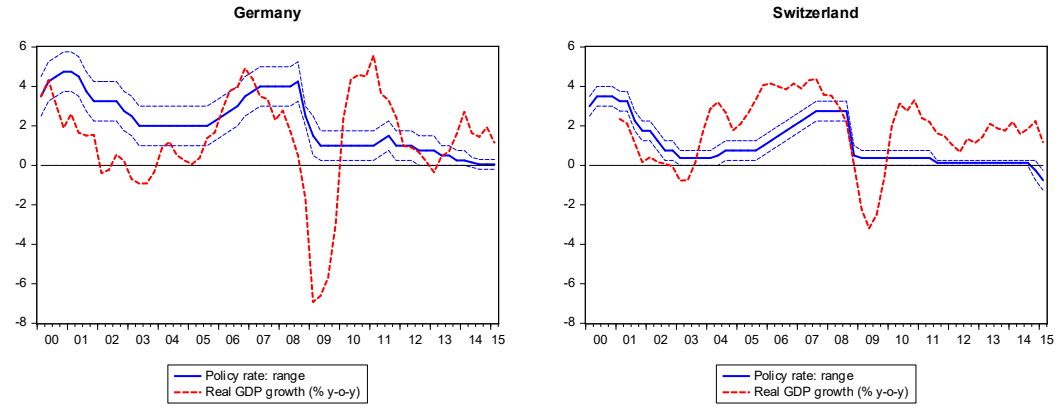
[5]Using 12,700 representative mortgage transactions between 2008 and 2013 from the online platform *Comparis*, Basten and Koch (2015) show that contracts with rates fixed for four years or more accounted for around 75% of all contracts in Switzerland, where contracts with rates fixed for ten years accounted for 35% of new contracts and contracts with rates 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.

ropean Central Bank (ECB). In increasing order of the value of the rates, these are the rate on the deposit facility, the rate on the main refinancing operations and the rate on the marginal lending facility. For Switzerland, the figure plots the midpoint of the target range, which is the three-month Swiss-Franc Libor, together with the range set by the Swiss National Bank (SNB). The considered time period is 2000 – 2015, given the introduction of the euro and the targeting of the three-month Swiss-Franc Libor by the SNB since 2000. Figure 1 illustrates the endogeneity of monetary policy because, as expected, the policy rates in Germany and Switzerland co-move with economic conditions, represented by the growth rate of real GDP in the figure. Thus, we need to construct a measure of exogenous changes in the policy rate for the empirical analysis.

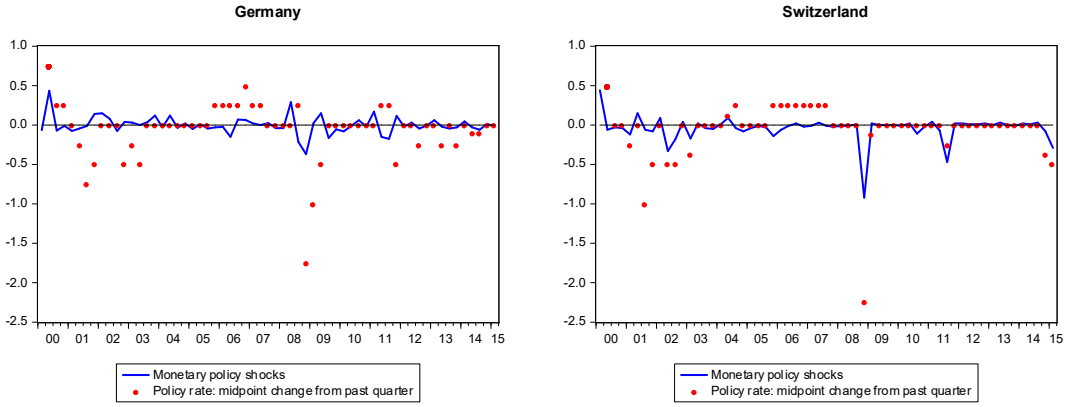
We identify monetary policy shocks by using high-frequency data on changes in financial-market expectations, which are contained in prices of futures contracts on interest rates in narrow time windows around the dates of monetary policy announcements. The identification of monetary policy shocks relies on the assumption that changes in the price of futures in these narrow time windows are due to news contained in the policy announcements and are not due to other events. 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 robustness for narrower time windows that are as short as 30 minutes.

As mentioned in the analysis of Wong (2018) 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 would consist of the true shock and an error which may be correlated with consumption or housing tenure. 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 5 of Table 9 in Appendix A.1, we check this issue by regressing the current quarterly shocks against their *past* values, with lags up to four quarters. We find no evidence of persistence for our constructed series of policy shocks for Switzerland. For the series of policy shocks for the euro area, only the coefficient of the shock with a lag of two quarters is significant while the coefficients for all other lagged shocks in the regression are not significant. We interpret this evidence as supporting, by and large, that our constructed series of policy shocks are true shocks.[6]

[6]In our analysis, we cumulate shocks for every year. Figure 6 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 a quarter. This is comforting because multicollinearity of the lagged shocks in the regressions is thus not a concern. In columns 2-4 and 6-8 of Table 9 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 of past shocks with a lag of four years or more. Note that the sample size is smaller in these regressions due to the longer lags.



(a) Policy rate range and real GDP growth (%)



(b) Monetary policy shocks and midpoint policy rate changes (%)

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 Thomson Reuters (RIC *FEIc1* and *FESc1*). German real GDP from FRED (Economic Data, Series *CLVMNACSCAB1GQDE*) and Swiss real GDP from SECO (Data, Table *qnaqcsa*, *ESA*, Reference *realq*, *B.1*b*). *Notes:* Quarterly data. In panel (a) we use the SNB target range for the Swiss policy rate. For Germany we use data for the rates on the deposit facility, the main refinancing operations (MRO) and the marginal lending operations of the ECB. The rates displayed use end of quarter values. In panel (b), the series of shocks is constructed using data of futures contracts for the 3-month Swiss-Franc Libor and the Euribor. Both the shocks and the midpoint changes are cumulated quarterly.

Figure 1: Policy rates and monetary policy shocks

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 the policymakers' information set or 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 critique by Rudebusch, 1998).

We retrieve market expectations about the policy rates by using price data of futures contracts on the policy rate or a close counterpart. The midpoint of the policy rates in Figure 1 is the rate on the main refinancing operations of the ECB for Germany 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 so that we use futures on the three-month Euribor instead. The Euribor is highly correlated with the rate on refinancing operations, as shown in Figure 7 in Appendix A.2.[7]

Panel (b) of Figure 1 plots our measure of the monetary policy shock, constructed from the unexpected price changes of the futures, together with the actual changes of midpoint policy rate changes. 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 panel (b) of 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. On other announcement dates instead, markets expected a reduction in the policy rate while the central bank kept the 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 -4 basis points for the SNB. The standard deviation of the shocks is 11 basis points for the ECB and 16 basis points for the SNB,[8] compared with the $25-35$ basis points reported in Wong (2018) for the Federal Reserve in the longer time period $1990-2007$. Given that some shocks in the sample are much larger than others, we check the robustness of our results in Appendix A.3.3 if we split the sample in 2007, and thus before the larger policy-

[7] 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 date so that 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 (2018) 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.

[8] 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.

rate shock during the financial crisis occurred. We discuss the results of these robustness checks in Sections 5 and 6.

As mentioned above, we further check robustness by constructing the shocks using narrower time windows to measure the price changes of the future contracts based on data at minute frequency provided by *TickDataMarket*. We consider 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. 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 compared with the Federal Reserve.

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 also makes an initial statement of the policy rate decision, which lasts approximately 30 minutes. Only in the quarterly meetings in June and December, this is directly followed by a press conference which lasts approximately one hour. The precise time of day of the announcement varies but is known in advance. The majority of statements started between 09:30 and 14:00 (CET) in our sample.[9] Given the similar structure of the announcements at the SNB, we also consider a time window of six hours around the announcement time, as for the ECB. Finally, we also check whether the results remain robust if we let the time window close right at the end of the press conference.[10] The results for the responses of housing tenure and consumption, using these alternative time windows to measure the monetary policy shocks, are reported in Appendices A.3.7 and A.4.2, and discussed in Sections 5 and 6.

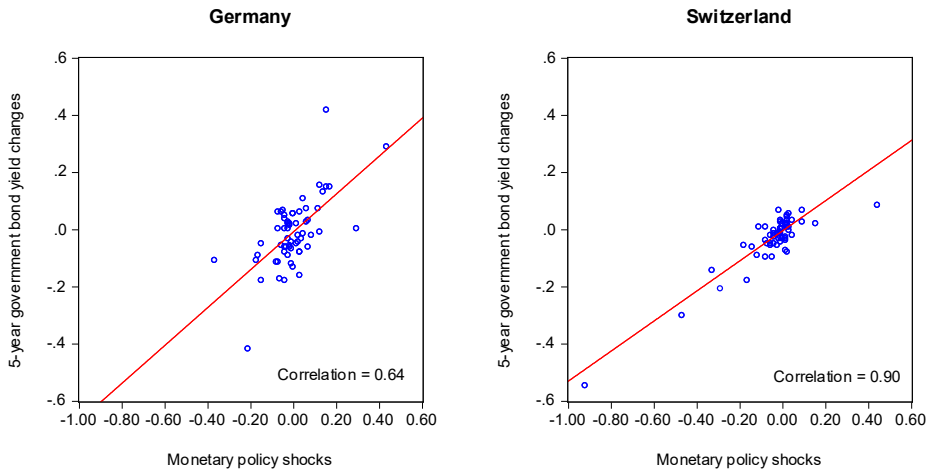
3.1 Pass through and persistent effects of shocks

Key for monetary policy transmission is the effect of the shocks on long-term interest rates. The results presented in this subsection indicate that the shocks indeed have a persistent effect on short-term rates and affect long-term interest rates, both in Germany and Switzerland.

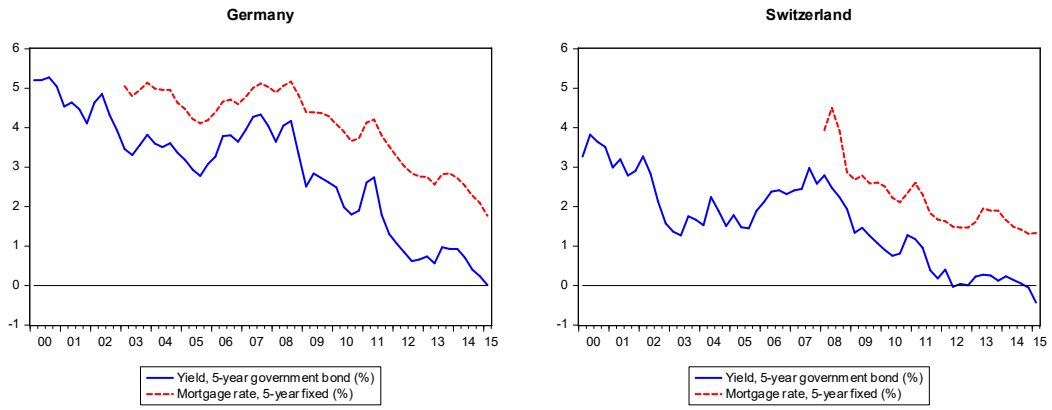
Panel (a) of Figure 2 shows that our measure of monetary policy shocks is highly correlated with changes in the yields of five-year government bonds in the same time window

[9]The initial SNB statements started between 08:50 and 17:45 (CET) in the sample period 2000Q1-2015Q1. The June and December meetings all started in the morning. In September 2011, December 2014 and January 2015, three extraordinary announcements were followed by a press conference.

[10]For Switzerland, the resulting time window ends either at the end of the announcement or at the end of the press conference (when there is one). This includes the extraordinary press conferences that took place on 06.09.2011, 18.12.2014 and 15.01.2015.



(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: Mortgage rates from Bundesbank (Statistics, Table *Effective interest rates of German banks*, Reference *BBK01.SUD118*) and SNB (Data Portal, Table *Interest rates, yields and foreign exchange market*, Subtable *Interest rates on new loan agreements, by product and maturity*, Cube ID *zikredlauf*). 5-year government bond yields from Thomson Reuters (RIC *DE5YT* and *CH5YT*). *Notes:* Panel (a) uses daily changes on announcement dates taking place between 2000Q1 and 2015Q1. Panel (b) displays end of quarter values for the mortgage rates, and quarterly averaged bond yields at the end of announcement dates.

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

Table 3: Persistent effects of monetary policy shocks

	Germany			Switzerland
6M Futures' implied rate	1.125***			0.945***
	(0.019)			(0.023)
9M Futures' implied rate	1.124***			0.885***
	(0.032)			(0.032)
12M Futures' implied rate	1.076***			0.830***
	(0.042)			(0.038)
15M Futures' implied rate	0.992***			0.800***
	(0.048)			(0.041)
18M Futures' implied rate	0.924***			0.769***
	(0.051)			(0.047)
21M Futures' implied rate	0.856***			0.748***
	(0.052)			(0.049)
3Y Government bond yield	0.662***			0.547***
	(0.058)			(0.042)
4Y Government bond yield	0.776***			0.453***
	(0.052)			(0.093)
5Y Government bond yield	0.639***			0.532***
	(0.052)			(0.041)
6Y Government bond yield	0.697***			0.561***
	(0.052)			(0.064)
	Nominal	*Real*	*Inflation*	
5Y Government bond yield*	0.850***	0.372***	0.478***	
	(0.109)	(0.096)	(0.091)	

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* and *CHMYT*, where *MYT* denotes maturity, and ISDN *DE0001030526* for the *Bobl* real bond). *Notes:** Estimates for the transmission to nominal rates, real rates and break-even inflation, using the 68 monetary policy announcements since the inflation-indexed *Bobl* bond has been issued in Germany in 2006. *** p-value<0.01. Standard errors 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 and Switzerland, respectively. The series are based on daily changes in the rates on the announcement dates in the period 2000Q1-2015Q1. The number of announcements in the sample period is 75 for Switzerland and 207 for Germany.

around the announcement dates, both in Germany and in Switzerland. Panel (b) of Figure 2 illustrates that quarterly values of interest rates for fixed-rate mortgages, which are not available at a high frequency and for the whole sample period, co-move strongly with the five-year government bond yields in both countries.

Table 3 provides evidence on the persistence of the monetary policy shocks. 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 into 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.[11] The size of the coefficients reported in Table 3, and hence the persistence of the effect of monetary policy shocks on the nominal rates, is of similar magnitude as the estimates for the U.S. reported in table 1 of Nakamura and Steinsson (2018).

For Germany, we can provide also evidence for the effect of monetary policy shocks on real rates for a shorter sample period. Inflation-indexed bonds have been issued only since 2006. We use the available data on five-year nominal and real government bonds because no indexed bonds with shorter maturities are issued. The estimates in the last row of Table 3 show that nearly half (44%) of the response of the nominal rate to the monetary policy shock can be attributed to the reduction of the real rate. The effect on break-even inflation accounts for the other half, 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 a positive unexpected change of the policy rate.

[11] 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 with daily data on yields 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 the short-term rates on the long-term rates would be even larger.

4 Household data on housing tenure and consumption

We use household-level data to analyze the transmission of monetary policy to the housing market and to consumption. Household-level data allow us to investigate the extent of heterogeneity in the transmission of monetary policy shocks across households with different ages, assets or liabilities.

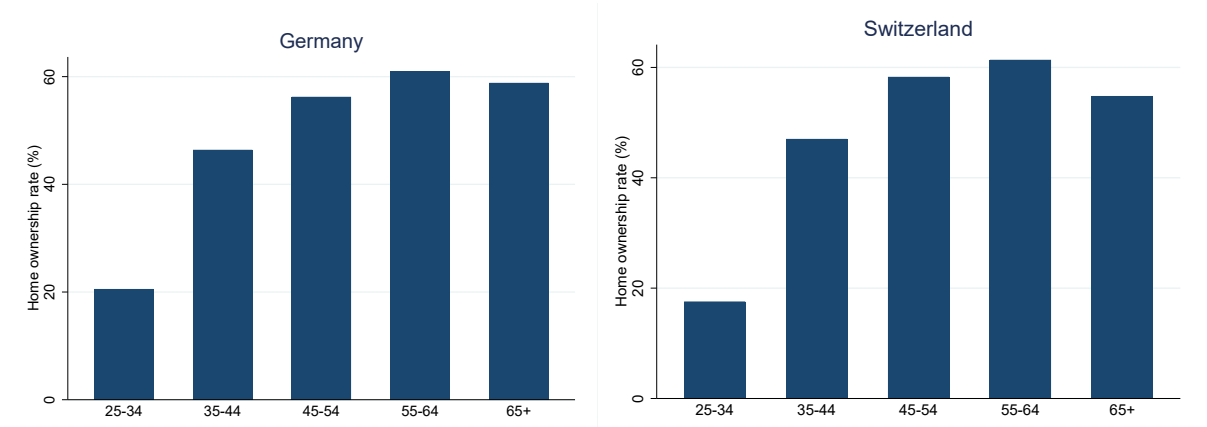
We use the annual data of the German Socioeconomic Panel (GSOEP) and the Swiss Household Panel (SHP) to estimate the effect of monetary policy shocks on housing tenure choice. The data are available at an annual frequency. Since households in the surveys are interviewed across all quarters and the sample size is sufficiently large, we can use variation across quarters during the time period $2000Q1 - 2015Q1$ available in both samples. Because of the lagged independent variables in the estimations, the sample for the estimation covers the period $2003Q1 - 2015Q1$ for both countries. The sample size is $136,718$ for Germany and $40,637$ for Switzerland, where the unit of observation is a household in a given year, observed in a specific quarter for that year.

Panel (a) of Figure 3 shows the familiar hump shape for the age profile of home ownership in Germany and Switzerland. As mentioned in Section 2, the home ownership rates in Germany and Switzerland are lower at young ages than in the U.S. and the U.K. and have a steeper age gradient until they peak at ages 55-64.

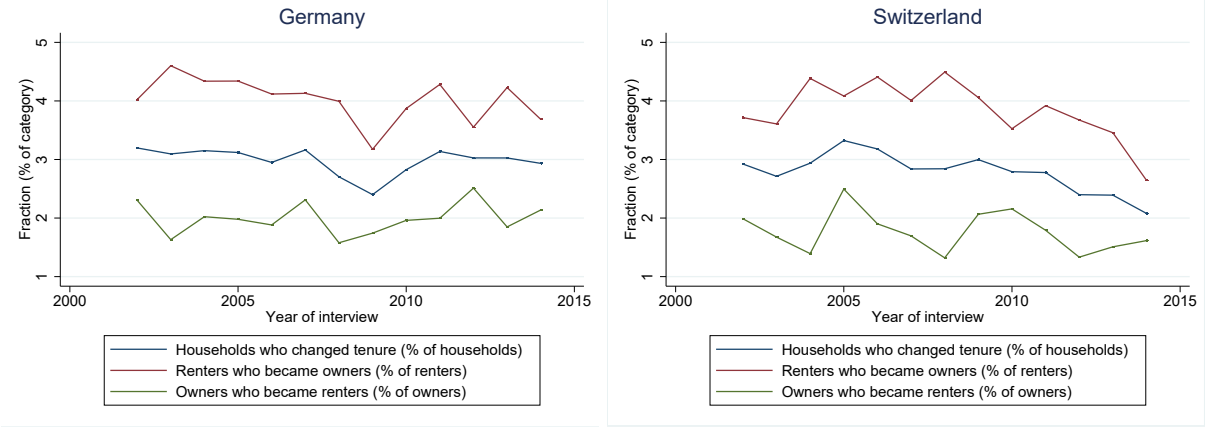
Panel (b) of Figure 3 shows that the fraction of renters who became home owners varies over time between 3.2% and 4.6% for Germany and between 2.6% and 4.5% for Switzerland. The fraction of owners that became renters in the sample period was lower between 1.6% and 2.5% for Germany and 1.3% and 2.5% for Switzerland. We will exploit the variation of 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 4 provides summary statistics for the different housing tenure groups in Germany and Switzerland. To learn about the characteristics of the households that changed housing tenure status, we distinguish renters that have remained renters (since the last survey in the previous year) from renters that have become home owners, and we distinguish home owners that have remained owners from those that have become renters. Table 4 shows that, as one would expect, renters that have become home owners tend to be younger than those who have remained renters, have a larger household size, are more likely married or live as a couple, have higher income and are more likely to work. The flow from home ownership to rental occurs at later ages, on average previous to retirement, where owners that become renters have relatively less income and are less likely to be married or live as a couple.

For Switzerland we are able to complement the panel data with repeated cross-sectional data on household income, consumption, rents and mortgage interest payments contained



(a) Home ownership by age group



(b) Flows between different types of housing tenure over time

Sources: Germany (GSOEP), Switzerland (SHP). *Notes:* Panel (a) shows averages for households in both countries. Panel (b) shows annual average flows.

Figure 3: Home ownership by age groups and flows between different types of housing tenure over time

Table 4: Summary statistics for housing-tenure groups in Germany and Switzerland

	Germany			
	Renters		**Owners**	
	Remained renter	Became owner	Remained owner	Became renter
Observations	63,646	2,621	69,065	1,386
Age (household head)	49.8	46.8	56.1	56.2
Household size (persons)	2.3	2.8	2.7	2.3
Number of children	0.6	0.8	0.6	0.5
In a couple (%)	56.4	77.3	79.1	59.4
Married (%)	44.3	62.3	74.7	49.9
Working (%)	63.1	73.2	61.8	56.2
Years of education	12.3	12.9	12.8	12.2
Gender (% male)	50.4	55.2	65.8	52.5
Domestic citizenship (%)	91.1	92.9	96.6	95.5
Gross household income (EUR, annual)	32,053	52,062	52,275	37,890
	Switzerland			
	Renters		**Owners**	
	Remained renter	Became owner	Remained owner	Became renter
Observations	18,750	735	20,784	368
Age (household head)	50.9	45.7	55.7	55.7
Household size (persons)	2.2	2.8	2.8	2.1
Number of children	0.4	0.8	0.6	0.4
In a couple (%)	51.8	76.3	78.7	51.6
Married (%)	41.3	61.2	74.7	42.4
Working (%)	67.4	77.6	64.8	60.6
Years of education	13.4	14.2	13.6	13.6
Gender (% male)	36.0	36.6	38.1	37.5
Domestic citizenship (%)	87.5	90.2	93.7	94.8
Gross household income (CHF, annual)	99,134	145,360	134,149	101,711

Sources: Germany (GSOEP), Switzerland (SHP). *Notes:* Averages for households interviewed between 2003Q1-2015Q1 for both data sets. Changes in tenure refer to changes since the last survey in the previous year. In 2007Q4, a euro was worth 1.45 US-$ and a Swiss Franc was worth 0.87 US-$. See Appendix A.7 for further details on the construction of the variables and the sample.

Table 5: Summary statistics for household budget items of Swiss renters and mortgagors

	Renters	**Mortgagors**
Observations	16,292	14,515
Age	45	52
Household labor income	64,028	69,245
Rent expenditure	11,630	-
Mortgage interest payments	-	7,056
Nondurables expenditure	31,302	36,450
Durables expenditure	4,868	7,007

Sources: Switzerland (HABE). *Notes:* Amounts are household averages in CHF over the sample period, adjusted for household size and using 2007Q4 prices. A Swiss Franc was worth 0.87 US-$ in 2007Q4. See Appendix A.7 for further details on the construction of the variables and the sample.

in the Swiss household budget survey (*Haushaltsbudgeterhebung* or HABE). The data are published annually but households in the surveys are interviewed across all quarters so that we use variation across quarters during the time period 2003Q1-2014Q4.[12] The data also contain information to classify households as renters or mortgagors. Our sample consists of 16,292 renters and 14,515 mortgagors. Table 5 provides summary statistics for these two groups. Mortgagors are older than renters on average, have more income and can afford more expenditure on durables and non-durables.[13]

Further recent descriptions of the data are provided by Wagner et al. (2007) for the GSOEP, Voorpostel et al. (2017) for the SHP and BFS (2013) for the HABE. Appendix A.7 contains further information on the construction of the sample and the variables used in the regressions. In that appendix we also compare average labor income and consumption in the HABE to the corresponding measures from the national accounts, to show that the data quality is comparable to consumption surveys in other developed countries.

[12] As for the estimations based on the SHP and GSOEP, the estimation sample starts in 2003Q1 because of the lagged independent variables.

[13] The items contained in the expenditures on non-durables and durables are listed in Appendix A.7. Note that average income in Table 5 is adjusted for household size and thus lower than the average income of Swiss households reported in Table 4. Although the available income measures in the SHP and HABE data are not directly comparable, we report that the average *total* household income is CHF 117,902 in the SHP and average household labor income is CHF 99,032 in the HABE. The medians are CHF 102,000 and CHF 93,890, respectively.

5 Response of housing tenure

We estimate the effect of monetary policy shocks on housing tenure in Germany and Switzerland. Since the shocks may induce purchases or sales of homes, we estimate the effect on both the transition from being a renter to becoming a home owner and vice versa. Home ownership 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 adjustment in the housing market: some renters become home owners and, at the same time, some home owners 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 can exploit variation at the quarterly frequency because we have information on the interview date of households. Given that households in the panel data are interviewed only at an annual frequency, we have to pool all the observations on renters to estimate the probability of becoming a home owner in each quarter and year, and we pool all the observations on home owners 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 will 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 in non-linear probit and logit specifications in Appendix A.3.2. 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 described above 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. The vector $\mathbf{x}_{irqt}$ contains a set of control variables, which vary at the household level.[14] In all of the regression specifications we control for common effects by

[14] We do not use aggregate variables as controls because this would contaminate our identification strategy. For example, unemployment and real GDP growth affect monetary policy decisions and, at the same time, 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 tried to achieve with our construction of

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.

We estimate the specification with ordinary-least squares, given that our measure of monetary policy shocks has been constructed to be an exogenous variable. The variation at the year-quarter level identifies the effect of the monetary policy shocks in our regressions. 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.3.5 we show that including additional lags amplifies the results that we present here, at the cost of less degrees of freedom, so that the main specification provides conservative estimates.

Table 6 summarizes the results for the effect of monetary policy shocks on housing tenure in Germany and Switzerland. In the benchmark specification reported in Table 6, we control for year and quarter dummies and add only age as additional control which is truly exogenous. The coefficients of the monetary policy shocks are thus identified by the interaction of quarter and year effects and we cluster their standard errors at quarter-of-interview level. In Appendix A.3.1 we show that our results are robust if we add additional controls for the region and for the household characteristics listed in Table 4.

Table 6: The effect of monetary policy shocks on housing tenure transitions

	Germany		Switzerland	
	Renter to Owner	Owner to Renter	Renter to Owner	Owner to Renter
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.008	-0.037***	-0.022**
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.014**	-0.020***	-0.007***
Monetary policy shock, sum Q(-9:-12)	-0.040**	0.003	-0.008***	0.001
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes
Observations	66,267	70,451	19,485	21,152
R^2	0.003	0.004	0.006	0.007
Effect of unexpected 25bps policy-rate cut	+1.88pp	+0.48pp	+1.63pp	+0.70pp

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is the respective change of housing tenure status. Standard errors are clustered at the 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 -25bps shock is obtained by multiplying the sum of the coefficients with -0.25.

The coefficients of the monetary policy shocks, reported in Table 6, are negative and highly significant. The results imply that an accommodative shock increases both the probability that renters become home owners and vice versa. As illustrated in the bottom row of the table for an unexpected fall of the policy rate by 25 basis points, the net

the series, omitted variables are uncorrelated with these shocks and do not bias the coefficient estimates.

effect on the transition probabilities is sizable. The probability that a renter becomes an owner increases by 1.88 percentage points in Germany and 1.63 percentage points in Switzerland. Likewise, the probability that an owner becomes a renter increases by 0.48 percentage points in Germany and 0.70 percentage points in Switzerland.[15]

These results suggest that the effect of the monetary policy shocks on the relative cost of owning versus renting causes changes in housing tenure by some households. Experiments in Hintermaier and Koeniger (2018) show that the changes in housing tenure that we find are by and large consistent with a calibrated life-cycle model that features a housing tenure choice and allows agents to accumulate wealth with an illiquid housing asset and a liquid financial asset. In such a model, the lower user cost of housing and the lower rent-to-price ratio, resulting from a fall in the real interest rate after a monetary policy shock as observed empirically in Table 3 of Section 3, induce a portfolio shift into owned housing for young age groups whereas the opposite is true for older age groups. Young households are more likely to be at the home-purchase margin whereas older households are more likely to be at the selling margin because of the usual tent-shaped wealth accumulation and decumulation pattern over the life cycle. Furthermore, the fall in the interest rate of (mortgage) debt is less relevant for older households because they are typically less leveraged.

To provide further evidence on the mechanism through which monetary policy shocks affect housing tenure choices, we show that the shocks indeed change rents, mortgage-interest payments, house prices and thus the rent-price ratio. In Section 6 we will show that an accommodative monetary policy shock (an unexpected decrease in the policy-rate) reduces both mortgage-interest payments and rental payments. The reduction of the interest rate after an accommodative monetary policy shock also triggers house-price increases that may induce some existing home owners to sell their homes, as they decumulate wealth towards the end of their life cycle. Table 7 shows that an unexpected decrease of the policy rate by 25 basis points increases house prices in Germany and Switzerland by $1.8 - 2.8$ percentage points.[16] The regression results for the different available price indexes in the respective columns of the table show that this result is robust for prices of different types of housing units.[17]

After presenting the main results, we now provide further discussion of the estimation

[15] These effects are obtained by adding the coefficients of the monetary policy shock reported in the table at all lags and by multiplying by -0.25, given that we consider a shock of -25 basis points.

[16] These effects are again obtained by adding the coefficients of the monetary policy shock at all lags and by multiplying by -0.25, given that we consider a shock of -25 basis points.

[17] Given that our household-level data sets do not contain precise information on the location of the household, we cannot match these data with information on local house prices to investigate this transmission channel in further detail. Changes of house prices at the coarse regional level do not help to explain housing-tenure decisions because there is a lot of heterogeneity in house-price dynamics within these regions.

Table 7: The effect of monetary policy shocks on house price growth

	Germany			Switzerland	
	All dwellings	New-built	Existing	Flats	One-family houses
Monetary policy shock, sum Q(-1:-4)	-2.368	-2.781	-2.293	-4.654***	-3.046***
	(1.842)	(2.255)	(2.015)	(0.800)	(0.670)
Monetary policy shock, sum Q(-5:-8)	-0.755	-4.799**	-0.030	-2.467***	-2.746***
	(1.638)	(2.006)	(1.792)	(0.835)	(0.698)
Monetary policy shock, sum Q(-9:-12)	-5.403***	-3.563*	-5.742***	-0.830	-1.342*
	(1.518)	(1.858)	(1.661)	(0.807)	(0.675)
Observations	49	49	49	49	49
R^2	0.246	0.211	0.226	0.446	0.368
Effect of unexpected 25bps policy-rate cut	+2.13pp	+2.79pp	+2.02pp	+1.99pp	+1.78pp

Sources: BIS (Statistics, Property prices statistics, references *Q:DE:0:1:0:1:6:0*, *Q:DE:0:1:1:1:6:0*, *Q:DE:0:1:2:1:6:0*, *Q:CH:0:2:0:2:0:0*, *Q:CH:0:8:0:2:0:0*). *Notes:* *** p<0.01. Standard errors are reported in brackets. The table reports the coefficients of separate regressions for house price growth against the monetary policy shocks series and a constant. The quarterly house price indexes are not seasonally-adjusted. The dependent variable is year-on-year house price growth (in %). The cumulative effect over three years of a -25bps shock is obtained by multiplying the sum of the coefficients with -0.25.

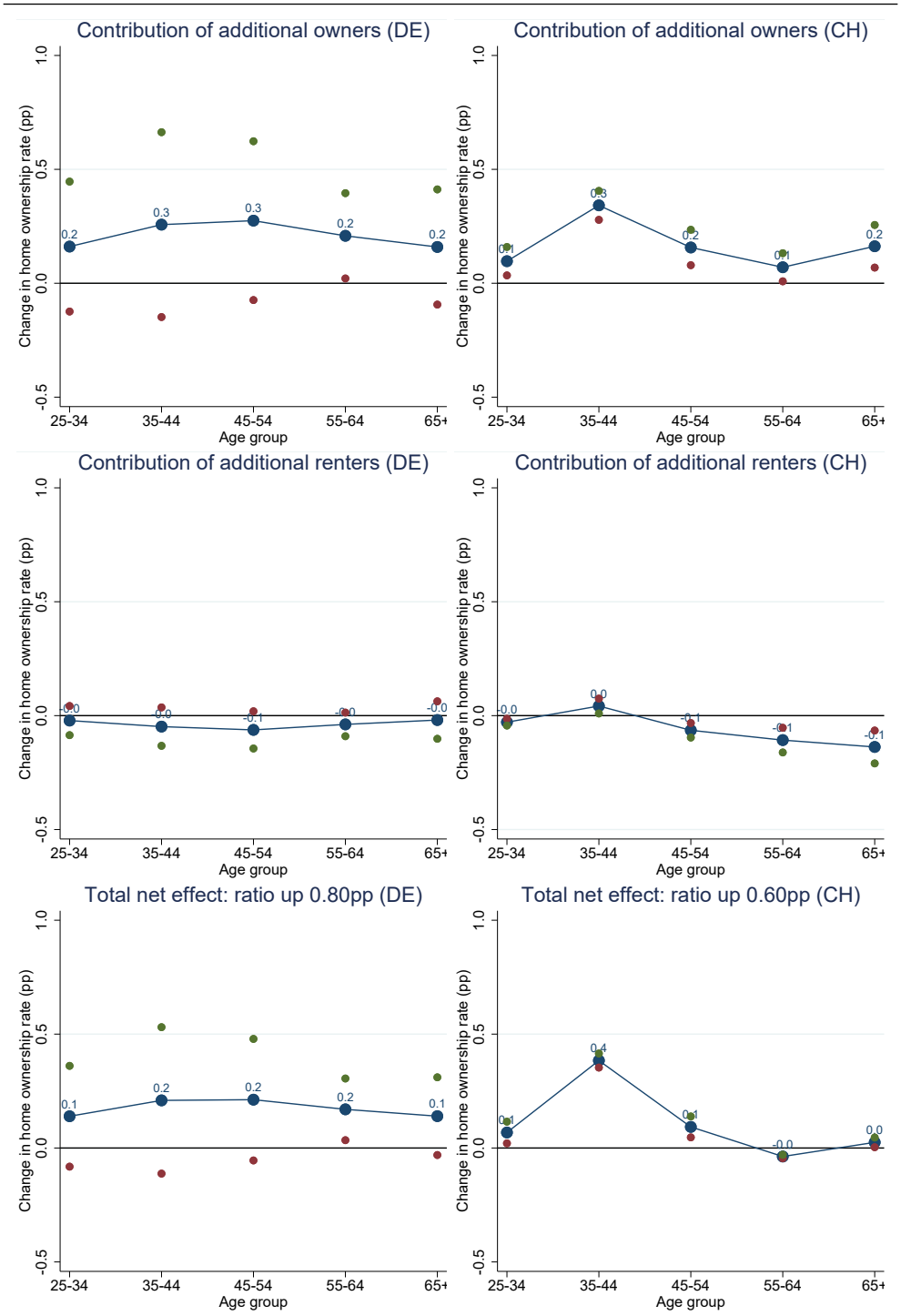
results in Table 6 for the effect of the monetary policy shocks on housing tenure. The point estimates of the coefficients for the lagged shocks indicate that, in Switzerland, the effect of the monetary policy shocks on housing tenure is strongest in the first year after the shock and then fades away. For Germany instead the effect seems most sizable at longer lags.

The estimates suggest that monetary policy shocks do not merely affect the timing of housing-tenure decisions over the life cycle of households but that they induce changes in housing tenure that would not have happened otherwise. If the shocks only shifted the timing, an increase in the transition probability from rental to owner occupation in the first year, for example, should be followed by a *de*crease in this transition probability at further lags. That is, some of the shocks with larger lags then should have a significant positive coefficient. Our results show that this is not the case, considering lags up to three years.[18]

We illustrate the extent to which the monetary policy shocks have heterogeneous effects across age groups. Figure 4 displays the unconditional effect of the monetary policy shocks on the home ownership rate by age group.[19] The figure shows that the net effect

[18]Given our short sample period, we have checked robustness for specifications with lags up to six years. The results reported in Tables 18 and 19 in Appendix A.3.5 show the robustness, in particular for the probability of becoming an owner which drives the net effect on home ownership in our results.

[19]The effects reported are obtained with the regression specifications reported in Table 6, augmented by interactions of the monetary policy shocks with dummies for each age group. Since the estimated changes in probabilities are conditional on housing-tenure status, we have to weigh the estimates for the respective age group with the fraction of renters or home owners in that age group. These weights are based on the distribution of 2014 which is representative for the whole sample period. The weights would be similar if



Notes: The results are based on the regression specification in Table 6, adding interaction dummies for age groups. The graphs show the cumulative effect (over three years) of a 25bps shock on the housing tenure choice (as in Table 6), using the age distribution for the representative year 2014 in the SOEP and SHP samples, respectively, together with the fractions of owners and renters in 2014. The top charts show the effect of additional owners on the home ownership rate and the middle charts show the effect of the additional renters. The bottom charts show the net effect, obtained by combining the two effects which are estimated independently. All charts show 95% confidence intervals, with the respective upper and lower bound depicted by the green and red dots.

Figure 4: Effect of a -25bps shock on the home ownership rate

of a monetary policy shock on the home ownership rate is rather similar in both Germany and Switzerland. As shown in the bottom panel of Figure 4, an unexpected 25bps policy rate cut increases the home ownership rate by 0.8 and 0.6 percentage points in Germany and Switzerland, respectively. The decomposition in the top and middle panels of the figure shows how the effect of some renters becoming owners quantitatively dominates the effect of some owners becoming renters. The figure further reveals that the response of existing owners is more uniform across age groups in Germany than in Switzerland. In Switzerland, the response of the renters is offset by the response of owners for older households so that the net increase in home ownership is almost entirely driven by households with a head aged 35 – 44.

Our findings point to substantial differences in monetary policy transmission in Germany and Switzerland compared with the U.S. and the U.K. Figure E.1 in Cloyne et al. (2017) shows that housing tenure does not respond significantly to monetary policy shocks in the U.S. and the U.K. Figure 5 in Wong (2018) displays that the adjustment of loans in the U.S. housing market, due to refinancing of mortgages and new purchases of homes, is larger for young households. We find instead that there is a significant response of housing tenure in Germany and Switzerland, that the response is rather homogenous across age groups in Germany, and that the response is stronger in Switzerland at the later ages 35 – 44 than in Wong (2018). One reason for these differences may be that refinancing is much more costly and thus less common in Germany and Switzerland than in the U.S., as described in Section 2. Furthermore, differences in mortgage markets, tax incentives for home ownership, housing regulation and the resulting feedback to house prices imply differences in the characteristics of marginal home buyers and sellers in Germany and Switzerland compared with the U.S. and the U.K., as suggested by the evidence in Andrews and Sánchez (2011b) discussed in Section 2.

Our results indicate that monetary policy shocks also transmit to household debt in Germany and Switzerland, given that new home owners typically finance their housing purchases with a mortgage and new home owners tend to be more leveraged than existing home owners who have partly amortized their mortgage. Although highly policy relevant, lack of data unfortunately does not allow us to investigate whether monetary policy shocks have a quantitatively sizable effect on household debt in Germany or Switzerland. If leverage affects the marginal propensity to consume, we will capture part of this transmission channel of monetary policy in our analysis of the consumption responses to the shocks that we perform in Section 6.

we used the distribution for all sample years.

5.1 Robustness

Appendix A.3 contains all the robustness checks for the main regression specification reported in Table 6.

Further control variables.– Tables 10 and 11 report results if we add further control variables where we repeat the results for the benchmark specification at the beginning of each subtable for convenience. The additional control variables increase the explained variation in terms of the R^2-statistic without substantially affecting the coefficient estimates. This result is to be expected if our constructed monetary policy shocks are exogenous and thus are true surprises. In this case, omitted variables are uncorrelated with the shocks and do not bias the coefficient estimates. We thus prefer the parsimonious specification reported in Table 6, in which we reduce the risk of possible biases resulting from adding possibly endogenous variables to a minimum, because our goal is not to maximize the explained variation to forecast housing tenure changes.

Non-linear probit and logit specifications.– Tables 12 and 13 show that the marginal effects of the monetary policy shocks are very similar in the non-linear probit and logit specifications compared with the benchmark OLS specification, which supports the linearity assumption in our benchmark specification.

Sample split into years before and after the financial crisis.– In Tables 14 and 15 we check the robustness if we split the sample in 2007 and thus before the large policy-rate shock which occurred during the financial crisis. The coefficient estimates are remarkably robust given the much smaller number of quarter-year observations which identify the coefficient estimates for the monetary policy shocks in the respective subsamples. The results suggest that the effect of monetary policy shocks on housing tenure are somewhat stronger before 2007.

Asymmetric effects of positive and negative monetary policy shocks?– Tables 16 and 17 provide some evidence that the effect of positive and negative monetary policy shocks is asymmetric in Germany but less so in Switzerland. The results also suggest, however, that the limited variation in the data makes it difficult to identify such possible differences.

More lags of the shocks and estimation of separate coefficients for lagged shocks in each quarter.– Tables 18 and 19 show that the estimated effect on housing tenure is qualitatively robust to adding lags for the shock up to six years. The effect on the probability of becoming an owner, which is the driver of the total effect of the shocks on housing tenure, becomes a bit larger.[20] Tables 20 and 21 show that separately estimating the coefficients of lagged monetary policy shocks for each quarter provides similar insights as the bench-

[20]Note that in the second column of each subtable we report the results of the benchmark specification, estimated on the smaller sample required for the specification with more lags. The estimated coefficients for the benchmark specification are very similar for this smaller sample that starts in the year 2006Q1, given that the sample is constructed to estimate the effect of lagged shocks up to six years.

mark specification in which we cumulate the shocks by year. We thus prefer the more parsimonious specification as benchmark.

Higher-frequency shocks.– In Tables 22 and 23 we show that our findings are robust if we allow for different time windows around the monetary policy announcements to measure the shocks. Figures 8 to 10 show that also the age patterns of the effects are robust. As explained in more detail Section 3, we consider a six-hour time window around the announcements as in Corsetti et al. (2018), a time window that closes right at the end of the press conference, and a 30-minute time window starting 10 minutes before the announcement as in the analysis of Gertler and Karadi (2015) and Nakamura and Steinsson (2018) for the U.S. We find that the size of the shocks becomes smaller as we shorten the time window, and more so for Germany than for Switzerland. The monetary policy announcements seem to need some time to be reflected in prices of the futures so that the series of the shocks to the policy rate for shorter time windows resembles a scaled-down version of the shock series measured over longer time windows. As a result, the size of the coefficient estimates reported in Tables 22 and 23 increases in absolute size for the shorter time windows. This is particularly visible for the effects of the shocks on the probability that renters become owners. 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 prices of futures and avoiding that other changes in that time window confound results.

Shocks conditional on stock market movements.– In Tables 24 and 25 we consider only monetary policy shocks that are negatively correlated with changes in the valuation of the stock market, as measured by the DAX and SMI, respectively. Jarociński and Karadi (2018) have argued that this reduces the bias resulting from confounding news shocks that may be associated with monetary policy announcements. We thus require that, for example, an accommodative shock, which unexpectedly lowers the interest rates, at the same time increases the stock-market valuation, as predicted by standard asset-pricing theory. If such a shock is associated with a decrease in stock-market valuation instead, we take this as a sign that the monetary policy announcement revealed also news about a worse economic outlook.

Given the possibility of such confounding news effects, we check the robustness of our results by discarding those shocks for which interest rate movements are positively correlated with the stock market. The results reported in Tables 24 and 25 show that, while some point estimates become larger in absolute terms in Switzerland, the overall pattern of the estimates remains unchanged both in Germany and Switzerland. The point estimates for the effect of policy rate shocks during the previous year increase by 30 – 50%, in absolute terms, for Switzerland. These larger estimates are consistent with the inter-

pretation that confounding news shocks imply a downward bias for the housing tenure response to policy rate shocks.

6 Reponse of non-housing consumption

We use the HABE dataset, available for the time period 2001-2014 in Switzerland, to investigate the effect of the monetary policy shocks on consumption and other budget items that enter the budget constraint of households. This generates further insights into the transmission of monetary policy in countries with low home ownership rates.

We find that the transmission of shocks to consumption and labor income is rather similar across mortgagors and renters.[21] This differs from findings by Cloyne et al. (2017) and Wong (2018) for the U.S. and the U.K. that mortgagors react more strongly to monetary policy shocks than renters because mortgagors are more leveraged and thus have a higher marginal propensity to consume. The suggestive evidence in Appendix A.5, further discussed below, suggests that, differently to the U.S. and the U.K., the financial situation and saving patterns of mortgagors and renters are very similar in Switzerland, consistent with a more similar marginal propensity to consume.

We now present the analysis in detail. The HABE contains information on durable and non-durable consumption, rental expenditures, mortgage interest payments and labor income. We construct a sample at the quarterly frequency using the information about the time of the interview of households. Appendix A.7 contains further information on the sample and the variables.

Denoting membership in the group of mortgagors or renters with index g, we estimate the specification

$$y_{igrqt} = \alpha + \left(\beta_0' + \beta_1' D_g\right)\mathbf{z}_{qt} + \gamma' \mathbf{x}_{igrqt} + D_g + D_r + D_q + D_t + \varepsilon_{igrqt},$$

where y_{igrqt} is the respective outcome variable of interest and, as before, the vector $\mathbf{z}_{qt}$ denotes the monetary policy shocks in the last three years, cumulated over quarters separately for each of the years. The vector $\mathbf{x}_{igrqt}$ contains control variables, which vary at the household level. In all of the regression specifications we control for effects by group D_g, quarter D_q and year D_t, and in robustness checks discussed below we also control for effects by region D_r.

We interact the monetary policy shocks with a group dummy D_g, which denotes whether a household has a mortgage on the primary residence, and also add the dummy for mort-

[21] We eliminate outright home owners from our sample because this group is too small in Switzerland. Renters and mortgagors account for 52.5% and 44.1% of the sample, respectively, whereas outright owners only account for the remaining 3.4%.

gagors D_g separately in the specification to capture possible permanent differences across renters and mortgagors.[22] This specification allows us to investigate whether the transmission of monetary policy in Switzerland differs across mortgagors and renters in a similar way as reported in Cloyne et al. (2017) and Wong (2018) for the U.S. and the U.K.

Table 8: The effect of monetary policy shocks on income and expenditures

	Labor income (logarithm)	Rental payments (logarithm)	Mortgage interest payments (logarithm)	Non-durable consumption (logarithm)	Durable consumption (logarithm)
Futures shock (3M): sum Q(-1:-4)	-0.051	0.092***	0.059	-0.033	-0.027
	(0.043)	(0.024)	(0.049)	(0.023)	(0.110)
Futures shock (3M): sum Q(-5:-8)	-0.021	0.030	0.068	-0.021	-0.013
	(0.037)	(0.018)	(0.043)	(0.025)	(0.096)
Futures shock (3M): sum Q(-9:-12)	-0.001	-0.005	0.013	-0.001	0.016
	(0.033)	(0.012)	(0.033)	(0.021)	(0.071)
Interaction mortgagors:					
Futures shock (3M): sum Q(-1:-4)	-0.000			0.018	-0.017
	(0.046)			(0.027)	(0.098)
Futures shock (3M): sum Q(-5:-8)	0.030			0.052*	-0.011
	(0.040)			(0.030)	(0.076)
Futures shock (3M): sum Q(-9:-12)	-0.044			-0.012	-0.146
	(0.033)			(0.030)	(0.097)
Age	8.954***	-0.474**	5.285***	1.715***	2.430***
	(0.662)	(0.191)	(0.693)	(0.163)	(0.480)
Age: squared	-10.990***	0.586***	-6.169***	-1.416***	-3.510***
	(0.780)	(0.196)	(0.663)	(0.165)	(0.477)
Dummy: mortgagors	0.087***			0.128***	0.474***
	(0.020)			(0.016)	(0.039)
Quarter dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	25630	16292	14515	30807	30807
R^2	0.046	0.018	0.051	0.047	0.051
Effect of unexpected 25bps policy-rate cut	1.8%	-2.9%	-3.5%	1.4%	0.6%

Notes: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are reported in brackets. The dependent variables are expressed in units of prices in 2007Q4, adjusted for household size and in logarithms. Standard errors are clustered at the quarter of the interview because the monetary policy shock does not vary at the household level. Labor income regressions are based on a sample of households aged less than 65 years, the retirement age. Age is divided by 100. The effect of a policy-rate cut of 25bps, displayed in the last row of the table, is obtained by first cumulating the coefficients of the monetary policy shock for the lags of three years, without considering the interaction terms for mortgagors, and then multiplying by -0.25.

In the benchmark specification reported in Table 8, we control for group, year and

[22] In the regressions for rental payments and mortgage-interest payments, the sample contains only renters or mortgagors, respectively, so that no explicit control for group D_g is included in the regression specification.

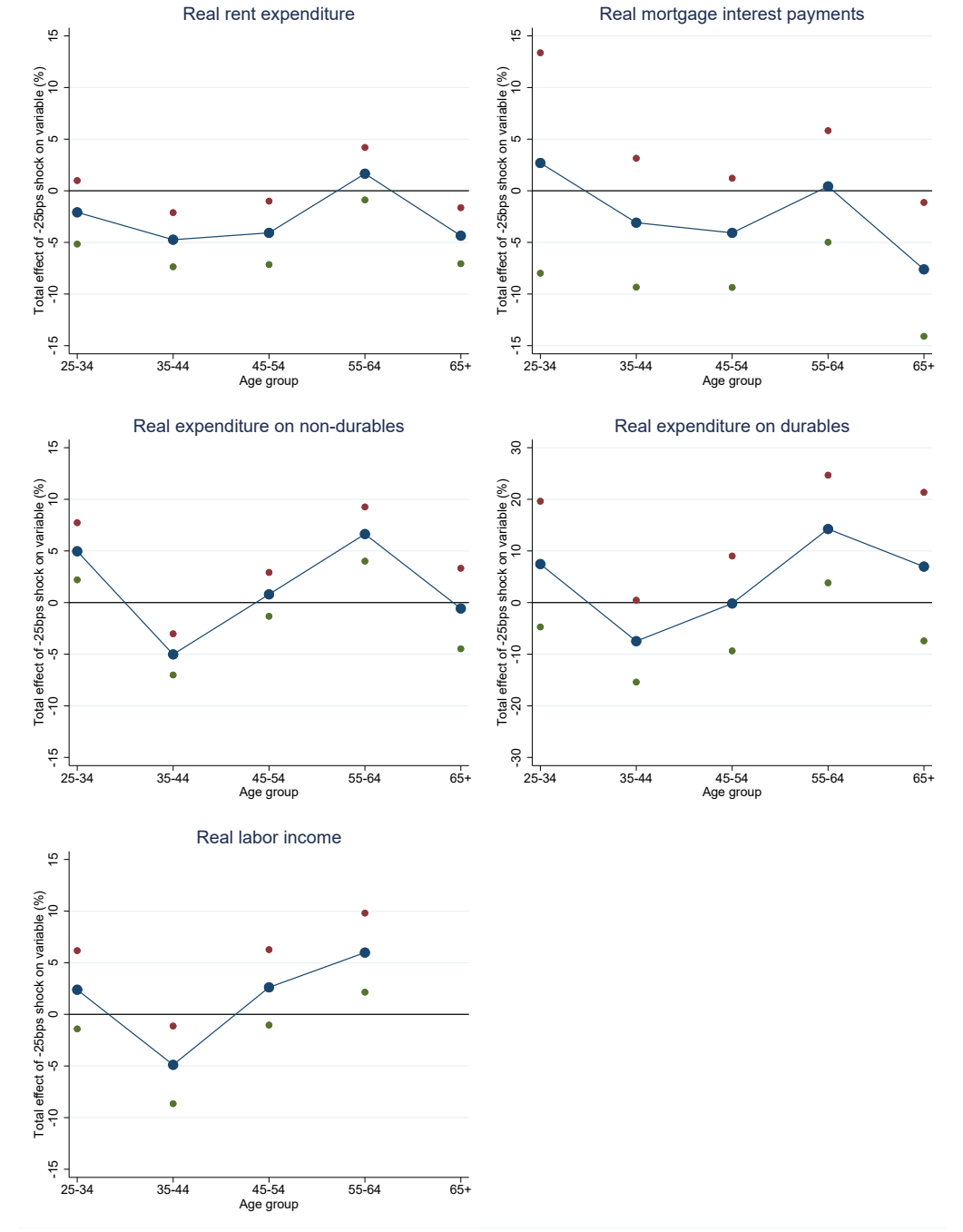
quarter dummies, and age. The coefficients of the monetary policy shocks are thus identified by the interaction of quarter and year effects and we cluster their standard errors at quarter-of-interview level. Although most of the responses to the shocks reported in Table 8 are not estimated precisely enough to be significant at the 10 percent level, the sign of the coefficients is as predicted by standard models: an accommodative monetary policy shock, i.e., a policy-rate cut, increases labor income and expenditure on non-durables and durables.

Table 8, column 3, further shows that an accommodative monetary policy shock lowers mortgage-interest payments. This confirms that a lower policy rate is passed through to the mortgage interest rate, as illustrated in subsection 3.1.[23] The results in column 2 show that rental payments also decrease after a policy-rate cut, and significantly so. This is different than in the U.S. and the U.K. (see figure 9 in Cloyne et al., 2017), and is likely related to the explicit indexation of rents to the mortgage-interest rate in Switzerland (see the discussion in footnote 4, Section 2).

The size of the responses to labor income and consumption for an unexpected policy-rate cut of 25 basis points, reported in the last row of Table 8, is of the same order of magnitude as in the U.S. and the U.K. reported in Cloyne et al. (2017), where the noise in the estimation does not allow for more precise comparisons. Although our estimations do not reveal any significant differences between mortgagors and renters for the responses of labor income and consumption, Figure 5 shows that there are significant differences in the responses across age groups. The results in the figure reveal that the response of consumption and labor income is stronger and significant at the 5%-level for households with a head aged 55 – 64. Furthermore, the response of durable consumption is significantly stronger, at the 1% level, than the response of non-durables for that age group. Figure 5 also shows that these effects are mitigated at the aggregate level by the responses of households with a head aged 35 – 44 which are of opposite sign.

The finding that the responses of consumption and income are strongest at ages 55-64 in Switzerland differs from findings for the U.S. where young households respond most strongly to monetary policy shocks (Wong, 2018). The results in Figure 5 further show that the responses of rental expenditure and mortgage-interest payments in Switzerland are rather similar across age groups, and that the differences in the consumption responses across age groups seem to be driven by the differences in the responses of labor income. Thus, the effect of monetary policy shocks on labor income, emphasized in the literature

[23]The coefficient estimates imply that the pass-through is less than full. The sum of the coefficients for the shocks at the lags up to three years is 0.14 whereas a full pass through would imply a total response of approximately 0.5. To see this, note that the unit of the shocks is in percent. Denoting the interest rate with r and debt with D, the derivative of $ln(rD)$ with respect to r then equals $1/(r \times 100)$, which, for $r = 0.02$, is equal to 0.5.



Notes: The results are based on the regression specification in Table 8 without the dummy for mortgagors and its interactions with the shocks, adding interaction dummies for age groups. The graphs show the cumulative effect over three years (in %) of an unexpected 25bps policy-rate cut. All charts show 95% confidence intervals, with the respective upper and lower bound depicted by the green and red dots.

Figure 5: Effect of a -25bps shock on expenditures and income

(e.g., Cloyne et al., 2017 and Kaplan et al., 2016), also shapes monetary policy transmission in countries with low home ownership rates such as Switzerland.

In order to further understand why the responses of mortgagors and renters are more similar in Switzerland than in the U.S. and the U.K., we compare the saving rates and the financial situation of these groups. Figure 15 in Appendix A.5 shows that the distribution of saving rates (abstracting from mortgage amortization) is very similar for renters and mortgagors, independent of whether they are younger than age 40 or not. Including amortization would imply that the saving rates are even larger for mortgagors than for renters. Le Blanc and Schmidt (2017) report similar results for Germany. This suggests that the marginal propensity to consume of mortgagors is not higher than for renters in Germany and Switzerland, which is an important difference to the U.S. or the U.K. where mortgagors are more likely to be wealthy hand-to-mouth households with a relatively higher marginal propensity to consume. This seems different in Germany and Switzerland. Indeed, as shown in Table 30 in Appendix A.5, mortgagors and renters give very similar answers when asked about their financial situation in the HABE dataset.[24]

Given the recent interest in the effect of monetary policy shocks on inequality (e.g., Coibion et al., 2017), we report the response of consumption inequality to monetary policy shocks in Appendix A.6. Figure 16 shows that consumption inequality has been quite stable during the sample period in Switzerland. For all three measure of consumption inequality reported in the appendix, we find that the consumption inequality observed in Switzerland is lower than in the U.S. but of similar size as in Germany.[25] Table 31 shows that, differently to the U.S., monetary policy shocks in Switzerland do not significantly affect consumption inequality and there is no clear pattern in the point estimates of the responses across the specifications with the different considered measures of consumption inequality. Further research is needed to determine whether this is due to the relatively small sample size or because of the smaller heterogeneity in the financial situation of households in Switzerland compared with the U.S., as discussed above.

6.1 Robustness

Appendix A.4 contains robustness checks for the main regression specification reported in Table 8. We performed a similar set of robustness checks as for the housing-tenure re-

[24]The HABE data do not contain further information on the balance sheets of mortgagors and renters.

[25]See Coibion et al. (2017), figure 1, for the U.S. and Fuchs-Schuendeln et al. (2010), figure 15, for Germany. Note that in Figure 16 in the appendix we report the differences in the logarithm of consumption at the 90th and 10th percentile for comparison with Coibion et al. (2017). And we report the ratio of consumption levels at the 50th and 10th percentile for comparison with Fuchs-Schuendeln et al. (2010). The ratio of consumption levels at the 90th percentile and 50th percentile can be obtained by applying the exponential operator to the values of the log differences.

gression. Given that these checks did not yield any further substantial insights, beyond of what we stated for the robustness checks for the housing-tenure regression in subsection 5.1, we only report results for a subset of these checks. Tables 26 to 29 show that the coefficient estimates are robust if we control for region effects and if we allow for additional interactions with the group dummy D_g for mortgagors. The coefficient estimates for the responses of labor income and non-durable consumption keep the same sign but decrease in size if the interactions are added.

Higher-frequency shocks.– Figures 11 to 13 show that the responses by age groups are robust if we allow for different time windows around the monetary policy announcements to measure the policy-rate shocks. As discussed in subsection 5.1, the series of the shocks to the policy rate for shorter time windows resembles a scaled-down version of the shock series measured over longer time windows. Thus, the size of the effect of a 25 basis point cut of the policy rate tends to become larger across Figures 11 to 13 if the policy-rate shocks are measured for shorter time intervals.

Shocks conditional on stock market movements.– In Figure 14 we show that the results of our benchmark estimation, particularly the described patterns across age groups, remain robust if we consider only monetary policy shocks that are negatively correlated with movements in stock-market valuations, as suggested by Jarociński and Karadi (2018).

7 Conclusion

Our analysis has shown that monetary policy transmission differs across countries with different home ownership rates. Monetary policy shocks cause more adjustment in the housing market in Germany and Switzerland than in the U.S. and the U.K. We find that an accommodative shock of 25 basis points increases the home ownership rate by 0.8 and 0.6 percentage points in Germany and Switzerland, respectively. Furthermore, we find that consumption responses to monetary policy shocks are more homogenous across mortgagors and renters, and that the responses have a different pattern across age groups in Germany and Switzerland compared with the U.S. and the U.K.

Our empirical evidence shows that the effectiveness of monetary policy in stimulating consumption in Germany and Switzerland depends less on housing tenure because the financial situation is less heterogenous across mortgagors and renters than in the U.S. or the U.K. Responses to monetary policy shocks in the housing market itself are more relevant in Germany and Switzerland instead, suggesting that unintended effects of monetary policy on housing tenure choices are more important in countries with low home ownership.

Our results point to trade-offs caused by differences in home ownership within a cur-

rency union, given that monetary policy is then common across member countries or regions in which the policy transmission differs. For further analysis of these trade-offs, more quantitative work is needed at the micro level to better understand the mechanisms through which monetary policy affects the housing market and consumption. Our findings suggest that such work has to consider that insights about the transmission of monetary policy obtained for a certain country are not easily transferrable to another country if household balance sheets differ, for example due to differences in home ownership rates.

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A Appendix

A.1 Correlation of monetary policy shocks over time

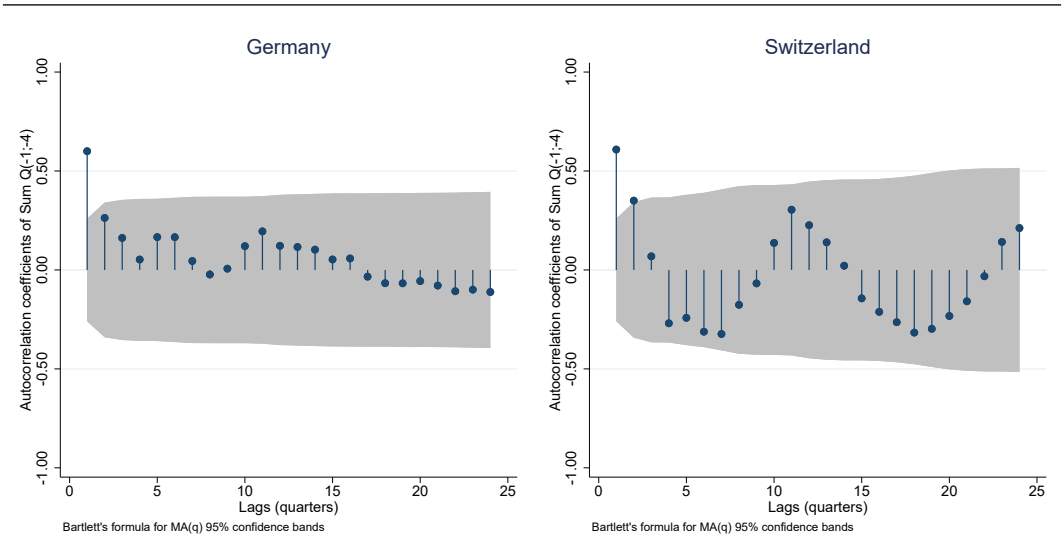
In this appendix we check whether the constructed monetary policy shocks are true shocks and thus not predictable by past values of the shocks. As mentioned in Section 3, private information of the monetary policy maker may introduce some persistence in our constructed series of shocks. Table 9 reports results of regressions of the monetary policy shocks on their lagged values. Columns 1 and 5 show results for regressions of the current quarterly shock on its past values for Germany and Switzerland, respectively. Columns 2-4 and columns 6-8 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 6 shows that for these moving sums of the shocks, the autocorrelations are not significant beyond a quarter. Hence, multicollinearity of the lagged shocks in the regressions is not a concern.

Table 9: Regressions of current and future monetary policy shocks on past shocks

	Germany				Switzerland			
	Current shock	Sum Q(+1,+4)	Sum Q(+5,+8)	Sum Q(+9,+12)	Current shock	Sum Q(+1,+4)	Sum Q(+5,+8)	Sum Q(+9,+12)
Monetary policy shock, Q(-1)	-0.055				-0.093			
	(0.137)				(0.141)			
Monetary policy shock, Q(-2)	-0.339**				-0.128			
	(0.137)				(0.141)			
Monetary policy shock, Q(-3)	-0.019				-0.015			
	(0.120)				(0.142)			
Monetary policy shock, Q(-4)	-0.014				-0.110			
	(0.119)				(0.130)			
Monetary policy shock, sum Q(-1:-4)		0.044	-0.177	0.149		-0.343*	-0.096	-0.151
		(0.145)	(0.135)	(0.148)		(0.172)	(0.186)	(0.179)
Monetary policy shock, sum Q(-5:-8)		0.010	0.125	-0.079		-0.131	0.003	-0.618***
		(0.129)	(0.123)	(0.136)		(0.182)	(0.196)	(0.187)
Monetary policy shock, sum Q(-9:-12)		0.134	-0.041	-0.033		0.060	-0.355*	-0.462**
		(0.122)	(0.116)	(0.130)		(0.172)	(0.179)	(0.171)
Observations	57	45	41	37	57	45	41	37
R^2	0.113	0.031	0.063	0.039	0.033	0.122	0.123	0.295

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.

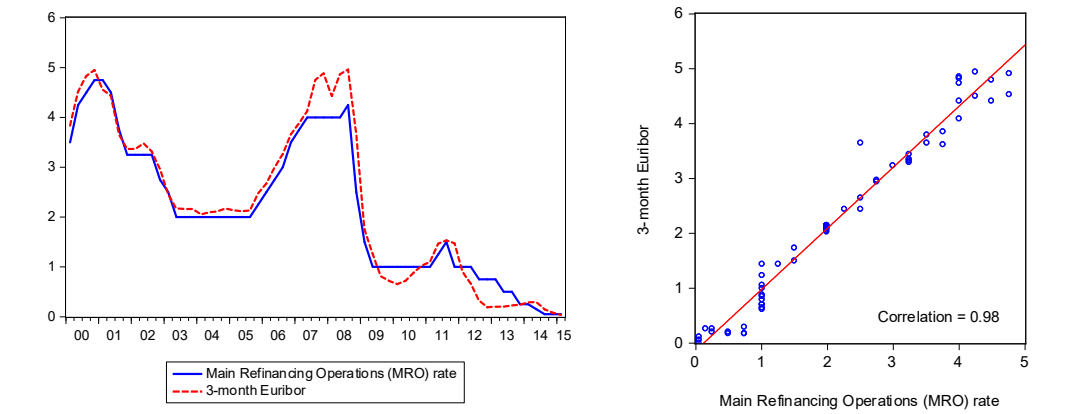


Notes: Correlograms of the moving sum of the quarterly shocks cumulated over a year.

Figure 6: Correlograms of the cumulated shock series

A.2 Correlation of Euribor with rate on main refinancing operations

This appendix provides evidence in Figure 7 that the three-month Euribor is highly correlated with the midpoint of the ECB policy rates, the rate on the main refinancing operations. This correlation is of interest, as mentioned in Section 3, because futures, which we use to identify monetary policy shocks, are not available for the ECB policy rates but are available for the Euribor.



Sources: Short-term rates from ECB (Statistical Data Warehouse, Table *ECB/Eurosystem policy and exchange rates*, Subtable *Official interest rates*). Both series contain end of quarter values.

Figure 7: Euribor and MRO rates

A.3 Robustness results for housing tenure

A.3.1 More control variables

Table 10: Regression output: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning			**Probability in Germany: from owning to renting**		
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.012	-0.012	-0.008	-0.008	-0.007
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.018	-0.019	-0.014**	-0.013**	-0.012*
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.037**	-0.033**	0.003	0.003	0.003
Age (reference person)	-0.000	-0.000	-0.002***	-0.004***	-0.004***	-0.004***
Age squared	-0.005	-0.009	0.175***	0.364***	0.374***	0.306***
Household size (persons)			-0.001			-0.002***
Number of children			0.007***			-0.001*
Married			0.012***			-0.016***
In a couple			0.014***			-0.003
Working			0.003			-0.000
Years of education			0.001***			-0.001***
Gender			-0.004**			-0.002*
German citizenship			0.016***			-0.007**
Gross income (household)			0.463***			-0.014
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	No	Yes	Yes	No	Yes	Yes
Observations	66267	66267	66267	70451	70451	70451
R^2	0.003	0.006	0.021	0.004	0.004	0.011

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are the probabilities of switching housing tenure status. Standard errors are clustered at quarter-of-interview. Individual characteristics refer to the household's reference person. Age is divided by 100 and household gross income by one million to display their coefficients conveniently in the table.

Table 11: Regression output: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning			**Probability in Switzerland: from owning to renting**		
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.037***	-0.033***	-0.022***	-0.022***	-0.024***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.019***	-0.017***	-0.007**	-0.007***	-0.012***
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.008***	-0.006**	0.001	0.001	-0.001
Age (reference person)	0.119**	0.128**	0.051	-0.526***	-0.523***	-0.559***
Age squared	-0.174***	-0.181***	-0.069	0.461***	0.458***	0.439***
Household size (persons)			0.005			-0.002*
Number of children			0.002			-0.006***
Married			0.007			-0.017***
In a couple			0.011**			-0.006
Working			-0.006			-0.001
Years of education			0.002***			0.000
Received a wealth transfer			0.058***			0.013**
Gender			-0.004			-0.000
Swiss citizenship			0.009**			0.002
Gross income (household)			0.190***			-0.019***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	No	Yes	Yes	No	Yes	Yes
Observations	19485	19485	19485	21152	21152	21152
R^2	0.006	0.009	0.027	0.007	0.007	0.018

Notes: See Table 10.

A.3.2 Probit and Logit specifications

Table 12: Marginal effects: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning			**Probability in Germany: from owning to renting**		
	OLS	Probit	Logit	OLS	Probit	Logit
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.010	-0.011	-0.008	-0.006	-0.007
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.013	-0.013	-0.014**	-0.011**	-0.011**
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.031***	-0.030***	0.003	0.004	0.004
Observations	66267	66267	66267	70451	70451	70451

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are the probabilities of switching housing tenure status. Standard errors are clustered at quarter-of-interview. The marginal effects are computed at the mean based on the benchmark regression specification in Table 6, which includes quarter and year dummies as well as controls for age and age squared. For the computation of the marginal effects in the logit and probit specifications, we set monetary policy shocks to zero which is the approximate value of the shocks' mean.

Table 13: Marginal effects: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning			**Probability in Switzerland: from owning to renting**		
	OLS	Probit	Logit	OLS	Probit	Logit
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.032***	-0.030***	-0.022***	-0.020***	-0.018***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.016***	-0.015***	-0.007**	-0.004	-0.003
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.005**	-0.004	0.001	0.002	0.003
Observations	19485	19472	19472	21152	21145	21145

Notes: See Table 12. For Switzerland, the probit and logit models are estimated without observations for households interviewed in 2015Q1. Only a few households have been interviewed in this last quarter of our sample and none of them switched tenure. Thus, including households interviewed in 2015Q1 would create identification problems in the probit and logit models for a binary outcome variable, given that our estimated specification includes dummies for each quarter. The results of the OLS regressions with a continuous outcome variable are robust to including households in quarter 2015Q1.

A.3.3 Sample splits into years before and after the financial crisis

Table 14: Regression output: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning			**Probability in Germany: from owning to renting**		
	Full sample	Year < 2007	Year ≥ 2007	Full sample	Year < 2007	Year ≥ 2007
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.122***	-0.018	-0.008	-0.008	-0.008
Monetary policy shock, sum Q(-5:-8)	-0.021	0.020	-0.047**	-0.014**	-0.021***	-0.012
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.026	-0.045***	0.003	0.015***	-0.005
Age (reference person)	-0.000	-0.001	-0.000	-0.004***	-0.005***	-0.004***
Age squared	-0.005	0.051	-0.029	0.364***	0.445***	0.337***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66267	19046	47221	70451	20184	50267
R^2	0.003	0.003	0.003	0.004	0.005	0.003

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are the probabilities of switching housing tenure status. Standard errors are clustered at quarter-of-interview. Age is divided by 100.

Table 15: Regression output: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning			**Probability in Switzerland: from owning to renting**		
	Full sample	Year < 2007	Year ≥ 2007	Full sample	Year < 2007	Year ≥ 2007
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.323**	-0.038***	-0.022***	-0.097	-0.020***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.150*	-0.023***	-0.007**	-0.040	-0.006**
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.098***	-0.006**	0.001	0.007	-0.001
Age (reference person)	0.119**	0.196	0.092*	-0.526***	-0.607***	-0.511***
Age squared	-0.174***	-0.245*	-0.151***	0.461***	0.553***	0.441***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19485	5662	13823	21152	5207	15945
R^2	0.006	0.005	0.006	0.007	0.007	0.008

Notes: See Table 14.

A.3.4 Allowing for asymmetric effects of positive and negative shocks

Table 16: Regression output: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning		**Probability in Germany: from owning to renting**	
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.066**	-0.008	0.005
Monetary policy shock, sum Q(-5:-8)	-0.021	0.009	-0.014**	-0.016***
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.056**	0.003	0.014***
Interaction Q(-1;-4): negative shocks		0.104***		-0.025**
Interaction Q(-5;-8): negative shocks		-0.046		-0.003
Interaction Q(-9;-12): negative shocks		0.048		-0.032***
Age (reference person)	-0.000	-0.000	-0.004***	-0.004***
Age squared	-0.005	-0.005	0.364***	0.363***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	66267	66267	70451	70451
R^2	0.003	0.003	0.004	0.004

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are the probabilities of switching housing tenure status. Standard errors are clustered at quarter-of-interview. Age is divided by 100. For the effect of negative monetary policy shocks, the coefficient of the respective interaction terms has to be added to the base coefficient to obtain the total effect.

Table 17: Regression output: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning		**Probability in Switzerland: from owning to renting**	
Monetary policy shock, sum Q(-1:-4)	-0.037***	0.169	-0.022***	-0.016
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.111	-0.007**	0.176
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.039	0.001	-0.202*
Interaction Q(-1;-4): negative shocks		-0.216		-0.008
Interaction Q(-5;-8): negative shocks		0.109		-0.184
Interaction Q(-9;-12): negative shocks		0.024		0.234*
Age (reference person)	0.118**	0.118**	-0.526***	-0.526***
Age squared	-0.174***	-0.174***	0.461***	0.461***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	19485	19485	21152	21152
R^2	0.006	0.006	0.007	0.007

Notes: See Table 16.

A.3.5 Allowing for more lags of the shocks

Table 18: Regression output: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning			**Probability in Germany: from owning to renting**		
	Full sample	2006Q1+	2006Q1+	Full sample	2006Q1+	2006Q1+
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.019	-0.033	-0.008	-0.008	0.001
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.047**	-0.083***	-0.014**	-0.011	0.009
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.044***	-0.080***	0.003	-0.004	0.020*
Monetary policy shock, sum Q(-13:-16)			-0.031			0.025***
Monetary policy shock, sum Q(-17:-20)			-0.045**			0.021***
Monetary policy shock, sum Q(-21:-24)			-0.015			0.008*
Age (reference person)	-0.000	0.000	0.000	-0.004***	-0.004***	-0.004***
Age squared	-0.005	-0.038	-0.037	0.364***	0.342***	0.341***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66267	51641	51641	70451	55102	55102
R^2	0.003	0.003	0.003	0.004	0.003	0.003

Notes: See Table 16.

Table 19: Regression output: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning			**Probability in Switzerland: from owning to renting**		
	Full sample	2006Q1+	2006Q1+	Full sample	2006Q1+	2006Q1+
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.038***	-0.045***	-0.022***	-0.021***	-0.020***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.023***	-0.037***	-0.007**	-0.007**	-0.000
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.007**	-0.030***	0.001	-0.001	0.009
Monetary policy shock, sum Q(-13:-16)			-0.026***			0.019*
Monetary policy shock, sum Q(-17:-20)			-0.048**			0.002
Monetary policy shock, sum Q(-21:-24)			0.010			-0.041
Age (reference person)	0.119**	0.104**	0.103**	-0.526***	-0.511***	-0.511***
Age squared	-0.174***	-0.158***	-0.157***	0.461***	0.444***	0.444***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19485	15411	15411	21152	17470	17470
R^2	0.006	0.006	0.006	0.007	0.007	0.007

Notes: See Table 16.

A.3.6 Allowing for separate coefficients of lagged shocks in each quarter

Table 20: Regression output: Housing tenure status changes in Germany, using quarterly shocks

	Probability in Germany: from renting to owning		**Probability in Germany: from owning to renting**	
Monetary policy shock, sum Q(-1:-4)	-0.014		-0.008	
Monetary policy shock, sum Q(-5:-8)	-0.021		-0.014**	
Monetary policy shock, sum Q(-9:-12)	-0.040**		0.003	
Monetary policy shock, Q(-1)		-0.054*		0.002
Monetary policy shock, Q(-2)		-0.075		-0.003
Monetary policy shock, Q(-3)		-0.063		0.003
Monetary policy shock, Q(-4)		-0.054		-0.012
Monetary policy shock, Q(-5)		-0.049		-0.009
Monetary policy shock, Q(-6)		-0.010		-0.012
Monetary policy shock, Q(-7)		-0.029		-0.014
Monetary policy shock, Q(-8)		-0.012		-0.013
Monetary policy shock, Q(-9)		-0.038		0.018
Monetary policy shock, Q(-10)		-0.052		0.027**
Monetary policy shock, Q(-11)		-0.055*		0.006
Monetary policy shock, Q(-12)		-0.035		0.006
Age (reference person)	-0.000	-0.000	-0.004***	-0.004***
Age squared	-0.005	-0.006	0.364***	0.361***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	66267	66267	70451	70451
R^2	0.003	0.003	0.004	0.004

Notes: See Table 14.

Table 21: Regression output: Housing tenure status changes in Switzerland, using quarterly shocks

	Probability in Switzerland: from renting to owning		**Probability in Switzerland: from owning to renting**	
Monetary policy shock, sum Q(-1:-4)	-0.037***		-0.022***	
Monetary policy shock, sum Q(-5:-8)	-0.020***		-0.007**	
Monetary policy shock, sum Q(-9:-12)	-0.008***		0.001	
Monetary policy shock, Q(-1)		-0.084**		-0.117
Monetary policy shock, Q(-2)		0.060		-0.142
Monetary policy shock, Q(-3)		-0.008		-0.064
Monetary policy shock, Q(-4)		-0.006		-0.054
Monetary policy shock, Q(-5)		-0.018		-0.044
Monetary policy shock, Q(-6)		0.026		-0.035
Monetary policy shock, Q(-7)		-0.010		-0.239
Monetary policy shock, Q(-8)		-0.018		-0.238
Monetary policy shock, Q(-9)		-0.013		-0.260
Monetary policy shock, Q(-10)		0.003		-0.106
Monetary policy shock, Q(-11)		0.005		-0.066
Monetary policy shock, Q(-12)		0.011		-0.007
Age (reference person)	0.118**	0.119**	-0.526***	-0.524***
Age squared	-0.174***	-0.175***	0.461***	0.459***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	19485	19485	21152	21152
R^2	0.006	0.006	0.007	0.008

Notes: See Table 14.

A.3.7 Robustness results for narrower time windows around monetary policy announcements

Table 22: Regression output: Housing tenure status changes in Germany

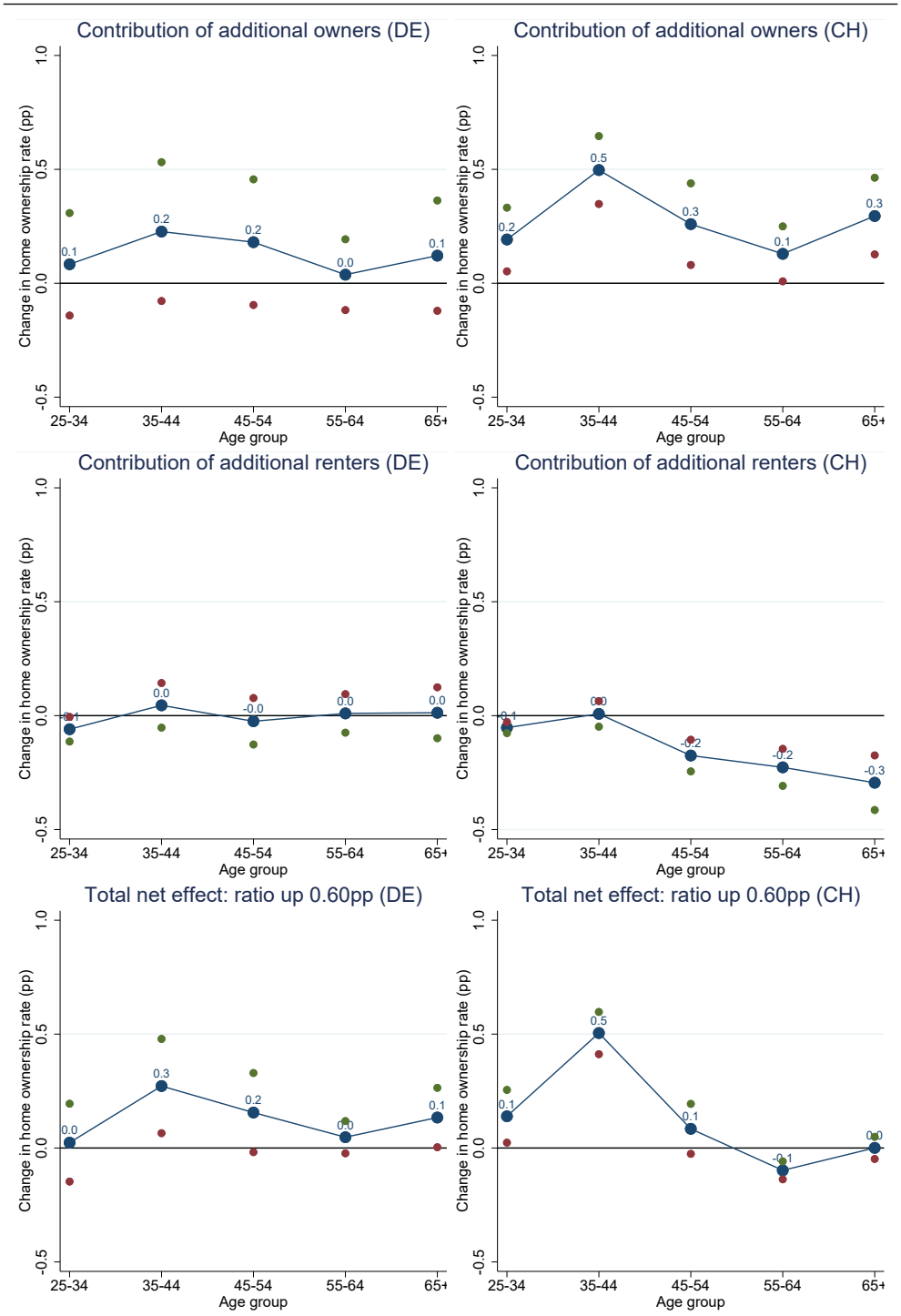
	Probability in Germany: from renting to owning				Probability in Germany: from owning to renting			
	Benchmark window	Six-hour window	Press conference window	30-minute window	Benchmark window	Six-hour window	Press conference window	30-minute window
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.014	-0.008	-0.091	-0.008	-0.001	-0.002	-0.008
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.019	-0.007	-0.188***	-0.014**	-0.003	0.001	0.029
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.015	-0.013	-0.122	0.003	0.000	0.003	0.036
Age (reference person)	-0.000	-0.000	-0.000	-0.000	-0.004***	-0.004***	-0.004***	-0.004***
Age squared	-0.005	-0.004	-0.004	-0.005	0.364***	0.365***	0.365***	0.365***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66267	66267	66267	66267	70451	70451	70451	70451
R^2	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004

Notes: See Table 14. The six-hour window starts 45 minutes before the announcement and stops 6 hours later. The press conference window starts 45 minutes before the announcement and stops at the end of the press conference. The 30-minute window starts 10 minutes before the announcement and stops 20 minutes after.

Table 23: Regression output: Housing tenure status changes in Switzerland

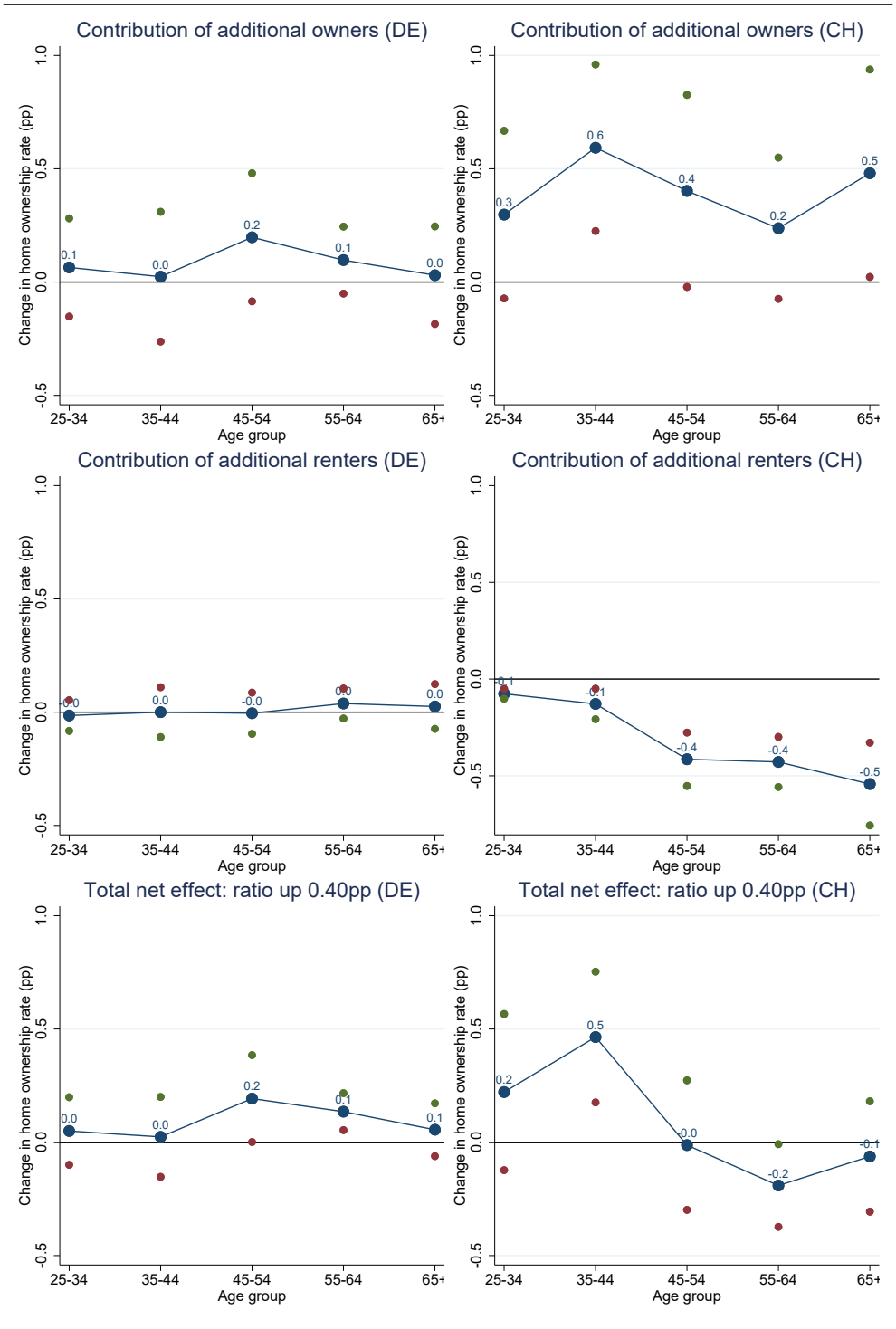
	Probability in Switzerland: from renting to owning				Probability in Switzerland: from owning to renting			
	Benchmark window	Six-hour window	Press conference window	30-minute window	Benchmark window	Six-hour window	Press conference window	30-minute window
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.056***	-0.097***	-0.110***	-0.022***	-0.041***	-0.079***	-0.104***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.040***	-0.036	-0.062	-0.007**	-0.028***	-0.064***	-0.049***
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.011	-0.029	-0.031	0.001	-0.002	-0.011	-0.011
Age (reference person)	0.119**	0.119**	0.120**	0.119**	-0.526***	-0.526***	-0.525***	-0.525***
Age squared	-0.174***	-0.174***	-0.175***	-0.175***	0.461***	0.461***	0.460***	0.460***
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19485	19485	19485	19485	21152	21152	21152	21152
R^2	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007

Notes: See Table 14. The six-hour window starts 45 minutes before the announcement and stops 6 hours later. The press conference window starts 45 minutes before the announcement and stops either at the end of the announcement or at the end of the press conference (when there is one). The 30-minute window starts 10 minutes before the announcement and stops 20 minutes after.



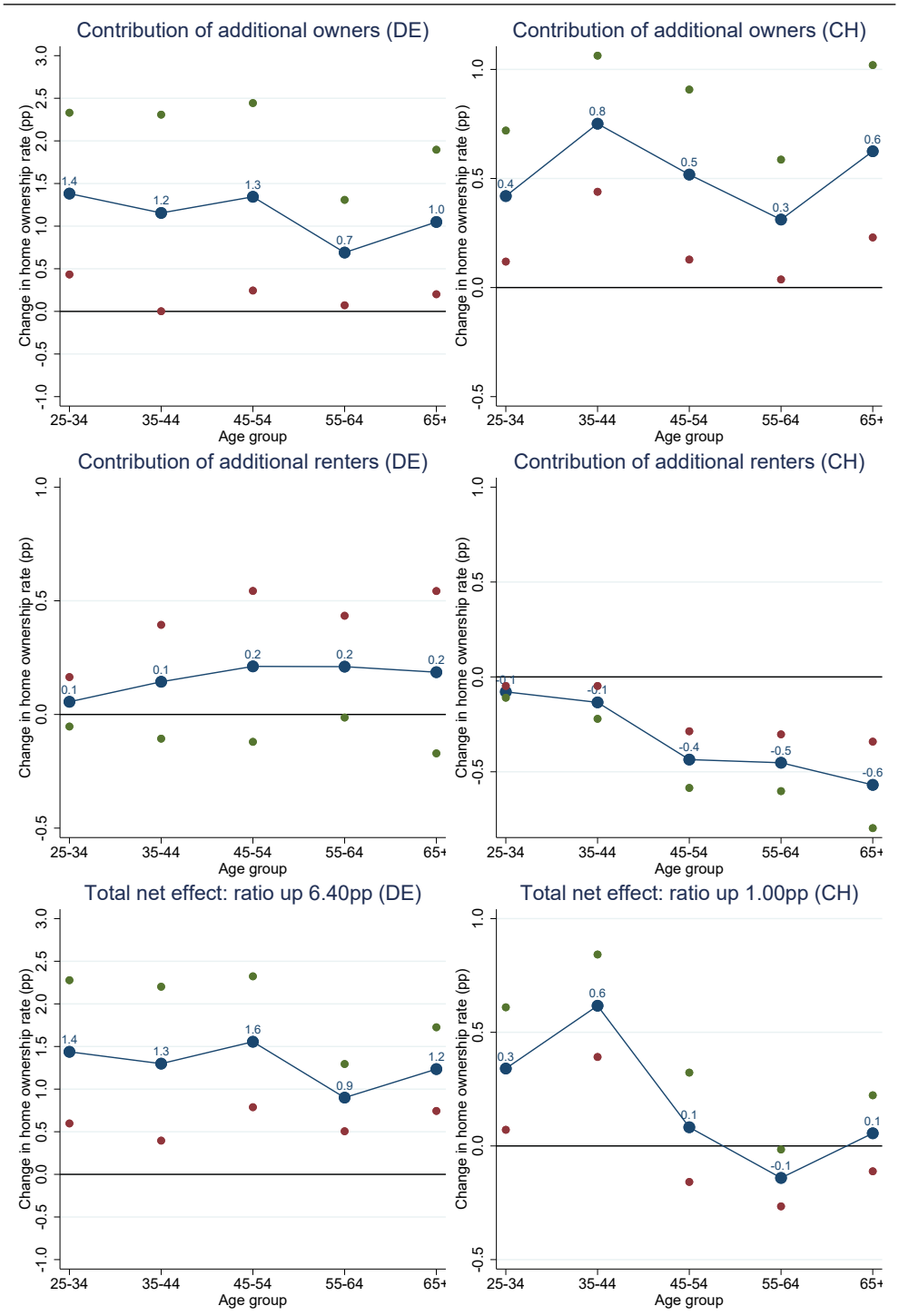
Notes: The results are based on the regression specification in Tables 22 and 23 using the six-hour window shocks, adding interaction dummies for age groups. The graphs show the cumulative effect (over three years) of a 25bps shock on the housing tenure choice (as computed in Table 6), using the age distribution for the representative year 2014 in the SOEP and SHP samples, respectively, together with the fractions of owners and renters in 2014. The top charts show the effect of additional owners on the home ownership rate and the middle charts show the effect of the additional renters. The bottom charts show the net effect, obtained by combining the two effects which are estimated independently. All charts show 95% confidence intervals, with the respective upper and lower bound depicted by the green and red dots.

Figure 8: Six-hour window: Effect of a -25bps shock on the home ownership rate



Notes: The results are based on the regression specification in Tables 22 and 23 using the press-conference window shocks, adding interaction dummies for age groups. See also the further notes to Figure 8.

Figure 9: Press-conference window: Effect of a -25bps shock on the home ownership rate



Notes: The results are based on the regression specification in Table 6 using the 30-minute window shocks, adding interaction dummies for age groups. See also the further notes to Figure 8.

Figure 10: 30-minute window: Effect of a -25bps shock on the home ownership rate

A.3.8 Robustness results for shocks that are negatively correlated with the response of the stock market

Table 24: Regression output: Housing tenure status changes in Germany

	Probability in Germany: from renting to owning		**Probability in Germany: from owning to renting**	
	Benchmark	Conditional on changes of stock market	Benchmark	Conditional on changes of stock market
Monetary policy shock, sum Q(-1:-4)	-0.014	-0.022	-0.008	-0.010*
Monetary policy shock, sum Q(-5:-8)	-0.021	-0.011	-0.014**	-0.021***
Monetary policy shock, sum Q(-9:-12)	-0.040**	-0.033*	0.003	-0.009*
Age (reference person)	-0.000	-0.000	-0.004***	-0.004***
Age squared	-0.005	-0.005	0.364***	0.363***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	66267	66267	70451	70451
R^2	0.003	0.003	0.004	0.004

Notes: See Table 14. The shocks conditional on stock market movements only consider announcements days on which the changes of the policy rate and the valuation of the stock market are negatively correlated. For Germany, this decreases the number of announcements from 207 to 98.

Table 25: Regression output: Housing tenure status changes in Switzerland

	Probability in Switzerland: from renting to owning		**Probability in Switzerland: from owning to renting**	
	Benchmark	Conditional on changes of stock market	Benchmark	Conditional on changes of stock market
Monetary policy shock, sum Q(-1:-4)	-0.037***	-0.049***	-0.022***	-0.033***
Monetary policy shock, sum Q(-5:-8)	-0.020***	-0.021***	-0.007**	-0.010**
Monetary policy shock, sum Q(-9:-12)	-0.008***	-0.007	0.001	0.001
Age (reference person)	0.119**	0.118**	-0.526***	-0.526***
Age squared	-0.174***	-0.174***	0.461***	0.461***
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	19485	19485	21152	21152
R^2	0.006	0.006	0.007	0.007

Notes: See Table 14. The shocks conditional on stock market movements only consider announcements days on which the changes of the policy rate and the valuation of the stock market are negatively correlated. For Switzerland, this decreases the number of announcements from 75 to 30.

A.4 Robustness results for regressions based on the HABE dataset

A.4.1 More control variables

Table 26: Regression output: Labor income

	Labor income (logarithm)		
	(1)	(2)	(3)
Futures shock (3M): sum Q(-1:-4)	-0.051	-0.042	-0.007
Futures shock (3M): sum Q(-5:-8)	-0.021	-0.015	-0.012
Futures shock (3M): sum Q(-9:-12)	-0.001	0.003	0.019
Interaction mortgagors:			
Futures shock (3M): sum Q(-1:-4)	-0.000	0.001	-0.069
Futures shock (3M): sum Q(-5:-8)	0.030	0.040	0.035
Futures shock (3M): sum Q(-9:-12)	-0.044	-0.041	-0.068
Age	8.954***	9.021***	9.056***
Age: squared	-10.990***	-11.082***	-11.127***
Dummy: mortgagors	0.087***	0.108***	0.105
Quarter dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Regional dummies	No	Yes	Yes
Year dummies, interacted with mortgagors	No	No	Yes
Quarter dummies, interacted with mortgagors	No	No	Yes
Regional dummies, interacted with mortgagors	No	No	Yes
Observations	25630	25630	25630
R^2	0.046	0.056	0.057

Notes: See Table 8. Regional dummies control for location in the seven Swiss regions.

Table 27: Regression output: Housing expenditure

	Rent payments (logarithm)		Mortgage interest payments (logarithm)	
	(1)	(2)	(3)	(4)
Futures shock (3M): sum Q(-1:-4)	0.092***	0.098***	0.059	0.078
Futures shock (3M): sum Q(-5:-8)	0.030	0.034*	0.068	0.087**
Futures shock (3M): sum Q(-9:-12)	-0.005	-0.002	0.013	0.025
Age	-0.474**	-0.466**	5.285***	5.199***
Age: squared	0.586***	0.576***	-6.169***	-6.131***
Dummy: mortgagors				
Quarter dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	No	Yes	No	Yes
Observations	16292	16292	14515	14515
R^2	0.018	0.086	0.051	0.070

Notes: See Table 26.

Table 28: Regression output: Non-durables expenditure

	Expenditure on non-durables (logarithm)		
	(1)	(2)	(3)
Futures shock (3M): sum Q(-1:-4)	-0.033	-0.028	-0.005
Futures shock (3M): sum Q(-5:-8)	-0.021	-0.019	-0.000
Futures shock (3M): sum Q(-9:-12)	-0.001	0.001	0.012
Interaction mortgagors:			
Futures shock (3M): sum Q(-1:-4)	0.018	0.019	-0.028
Futures shock (3M): sum Q(-5:-8)	0.052*	0.059*	0.018
Futures shock (3M): sum Q(-9:-12)	-0.012	-0.007	-0.023
Age	1.715***	1.704***	1.739***
Age: squared	-1.416***	-1.422***	-1.458***
Dummy: mortgagors	0.128***	0.147***	0.171***
Quarter dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Regional dummies	No	Yes	Yes
Year dummies, interacted with mortgagors	No	No	Yes
Quarter dummies, interacted with mortgagors	No	No	Yes
Regional dummies, interacted with mortgagors	No	No	Yes
Observations	30807	30807	30807
R^2	0.047	0.065	0.069

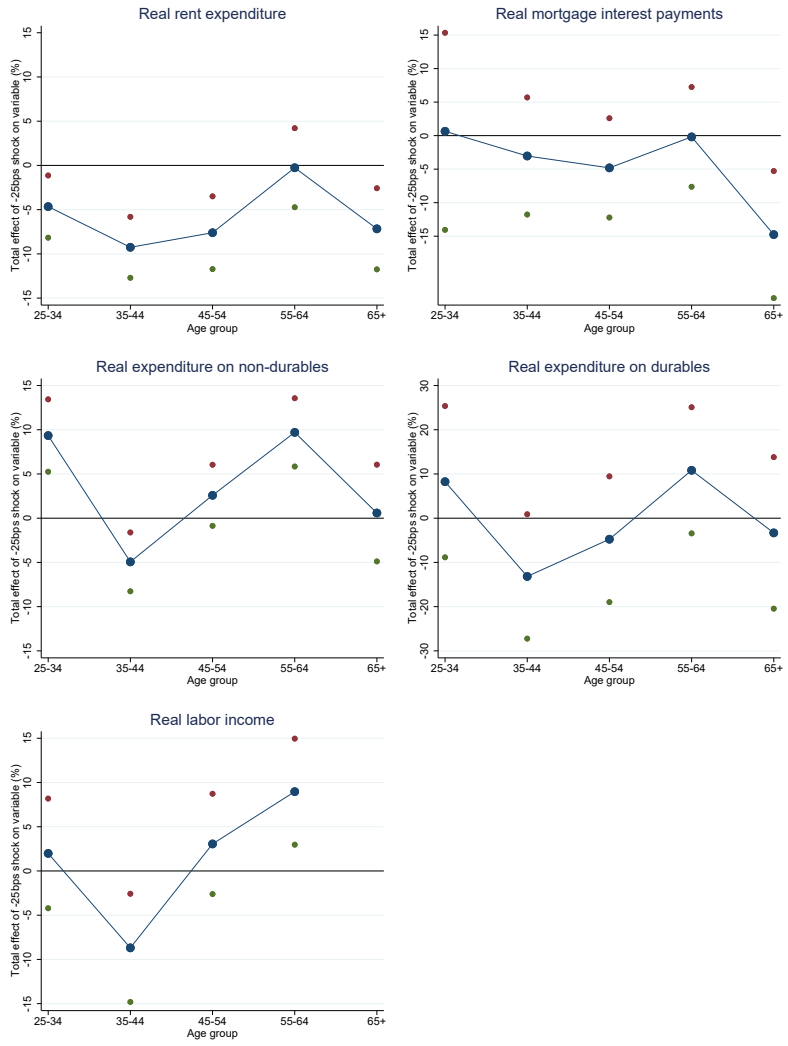
Notes: See Table 26.

Table 29: Regression output: Durables expenditure

	Expenditure on durables (logarithm)		
	(1)	(2)	(3)
Futures shock (3M): sum Q(-1:-4)	-0.027	-0.015	-0.032
Futures shock (3M): sum Q(-5:-8)	-0.013	-0.006	-0.007
Futures shock (3M): sum Q(-9:-12)	0.016	0.022	-0.020
Interaction mortgagors:			
Futures shock (3M): sum Q(-1:-4)	-0.017	-0.015	0.013
Futures shock (3M): sum Q(-5:-8)	-0.011	-0.004	-0.004
Futures shock (3M): sum Q(-9:-12)	-0.146	-0.144	-0.048
Age	2.430***	2.479***	2.515***
Age: squared	-3.510***	-3.569***	-3.612***
Dummy: mortgagors	0.474***	0.493***	0.495***
Quarter dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Regional dummies	No	Yes	Yes
Year dummies, interacted with mortgagors	No	No	Yes
Quarter dummies, interacted with mortgagors	No	No	Yes
Regional dummies, interacted with mortgagors	No	No	Yes
Observations	30807	30807	30807
R^2	0.051	0.055	0.057

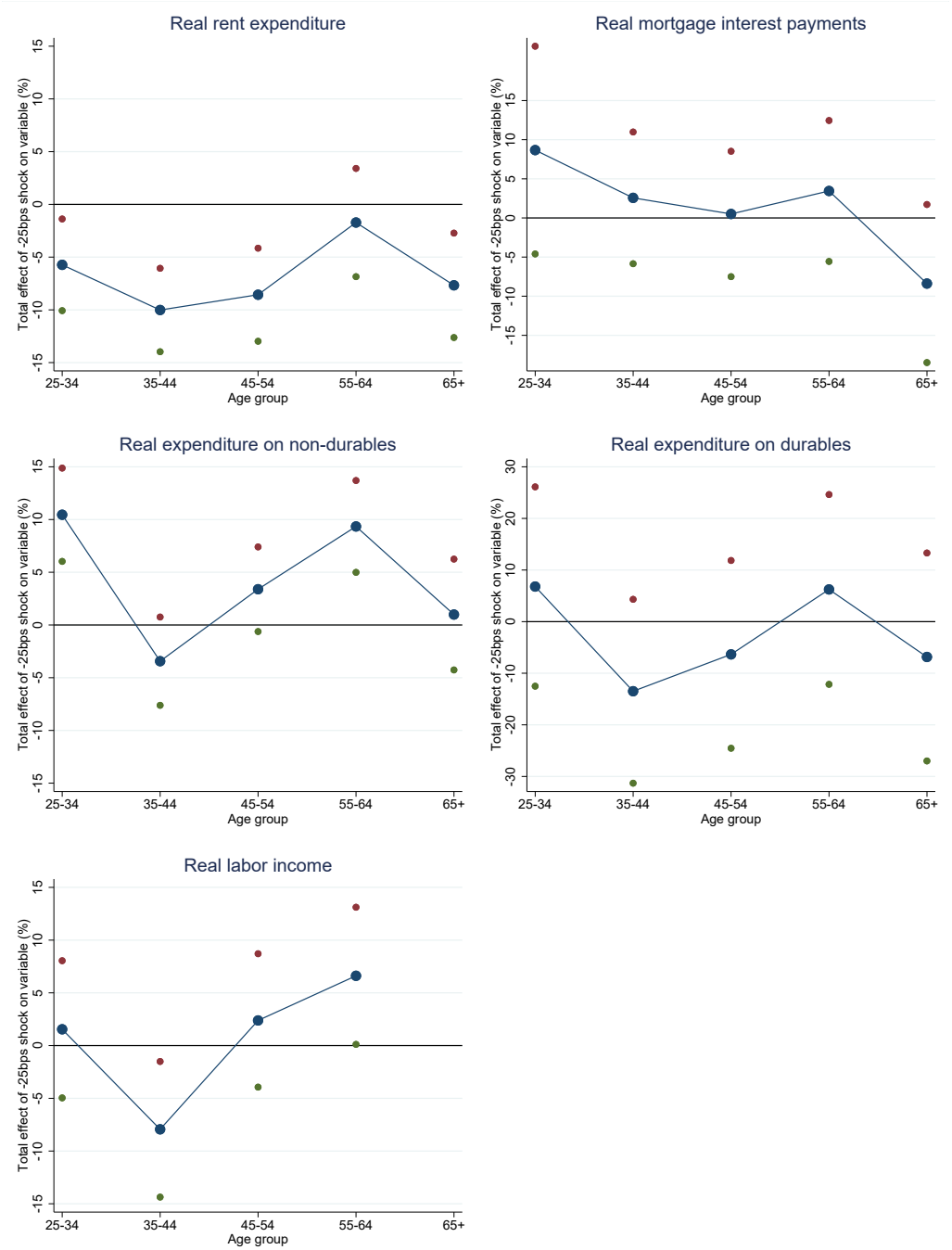
Notes: See Table 26.

A.4.2 Robustness results for narrower time windows around monetary policy announcements



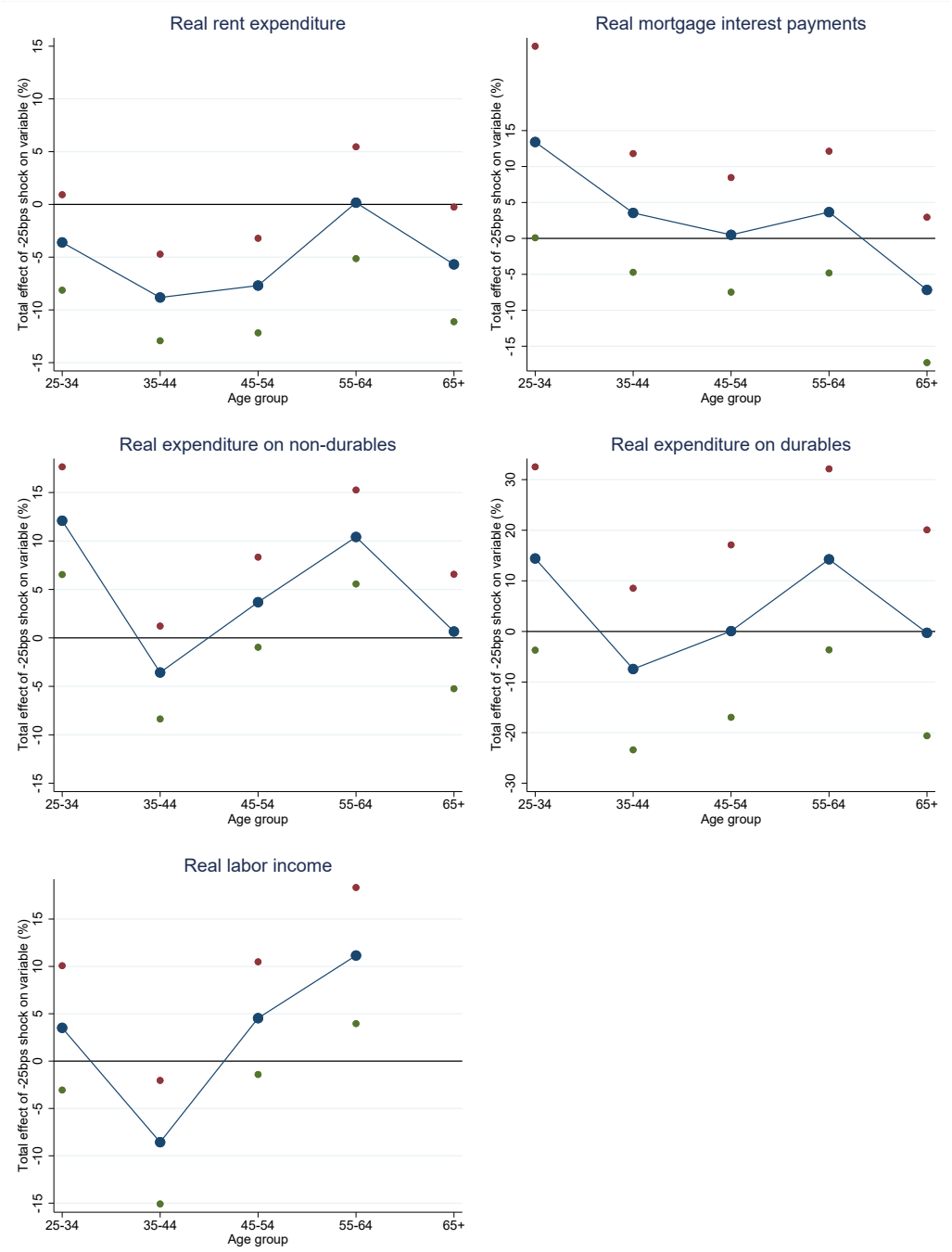
Notes: The results are based on the regression specification in Table 8 without the dummy for mortgagors and its interactions with the shocks, using the six-hour window shocks and adding interaction dummies for age groups. The graphs show the cumulative effect over three years (in %) of an unexpected 25bps policy-rate cut. All charts show 95% confidence intervals, with the respective upper and lower bound depicted by the green and red dots.

Figure 11: Six-hour window: Effect of a -25bps shock on expenditures and income



Notes: The results are based on the regression specification in Table 8 without the dummy for mortgagors and its interactions with the shocks, using the press-conference window shocks and adding interaction dummies for age groups. See also the further notes to Figure 11.

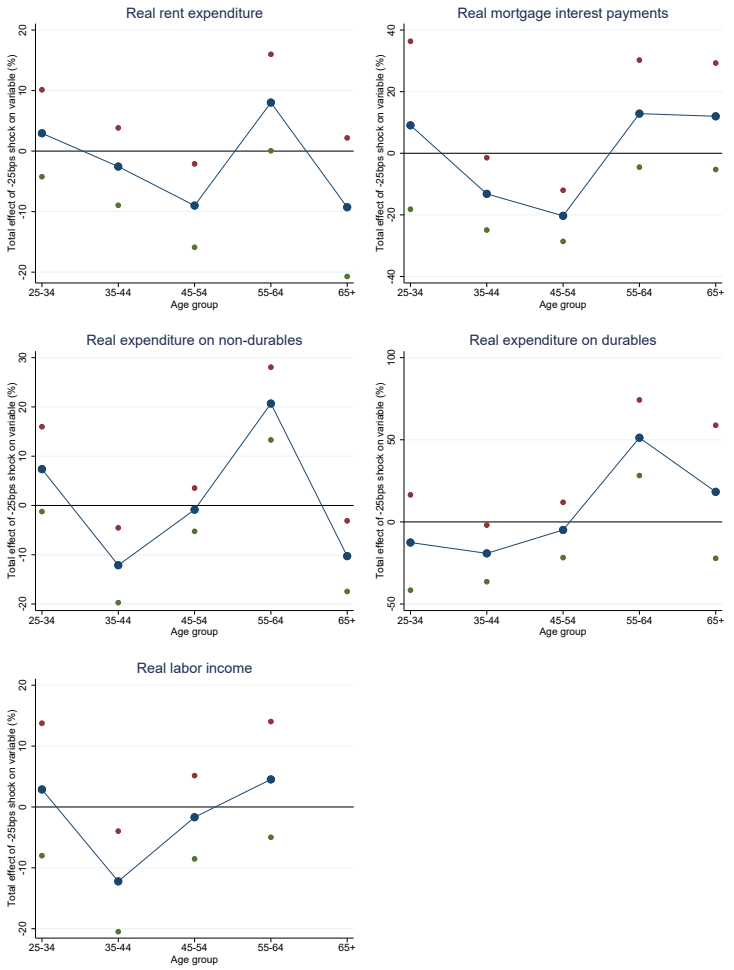
Figure 12: Press conference window: Effect of a -25bps shock on expenditures and income



Notes: The results are based on the regression specification in Table 8 without the dummy for mortgagors and its interactions with the shocks, using the 30-minute window shocks and adding interaction dummies for age groups. See also the further notes to Figure 11.

Figure 13: 30-minute window: Effect of a -25bps shock on expenditures and income

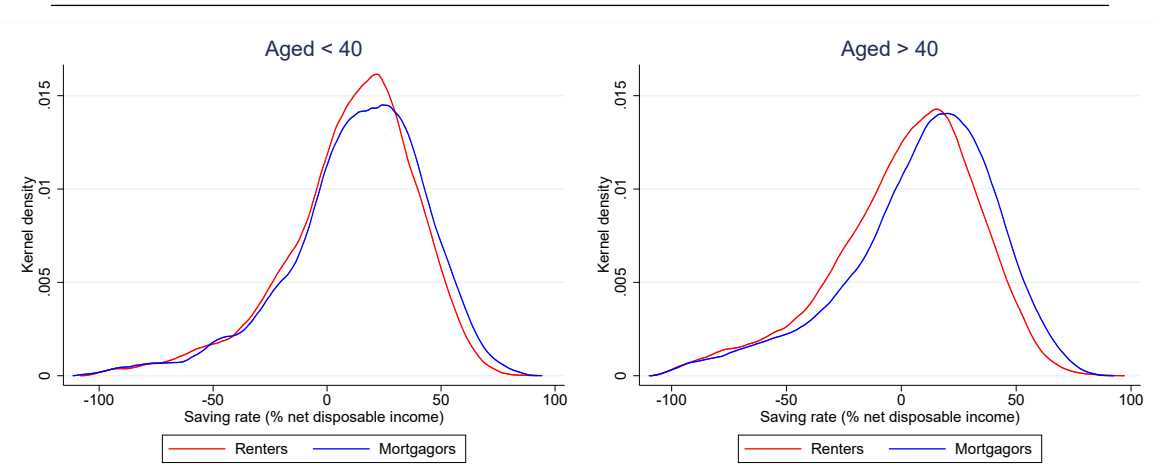
A.4.3 Robustness results for shocks that are negatively correlated with the response of the stock market



Notes: The results are based on the regression specification in Table 8 without the dummy for mortgagors and its interactions with the shocks, adding interaction dummies for age groups. The graphs show the cumulative effect over three years (in %) of an unexpected 25bps policy-rate cut. For constructing the shocks conditional on stock-market movements, we only consider announcements days on which the changes of the policy rate and the valuation of the stock market are negatively correlated. For Switzerland, this decreases the number of announcements from 75 to 30. All charts show 95% confidence intervals, with the respective upper and lower bound depicted by the green and red dots.

Figure 14: Effect of a -25bps shock on expenditures and income for an alternative identification of policy-rate shocks using stock-market movements

A.5 Saving rates and the financial situation of mortgagors and renters



Sources: HABE (SFSO). *Notes:* Net disposable income is the sum of labor income, wealth income and transfer income, minus social security contributions and taxes. Kernel density estimates with optimal bandwidth using data for 2006Q1-2014Q4. Wealth and transfer incomes, and social security contributions are not available for the previous years.

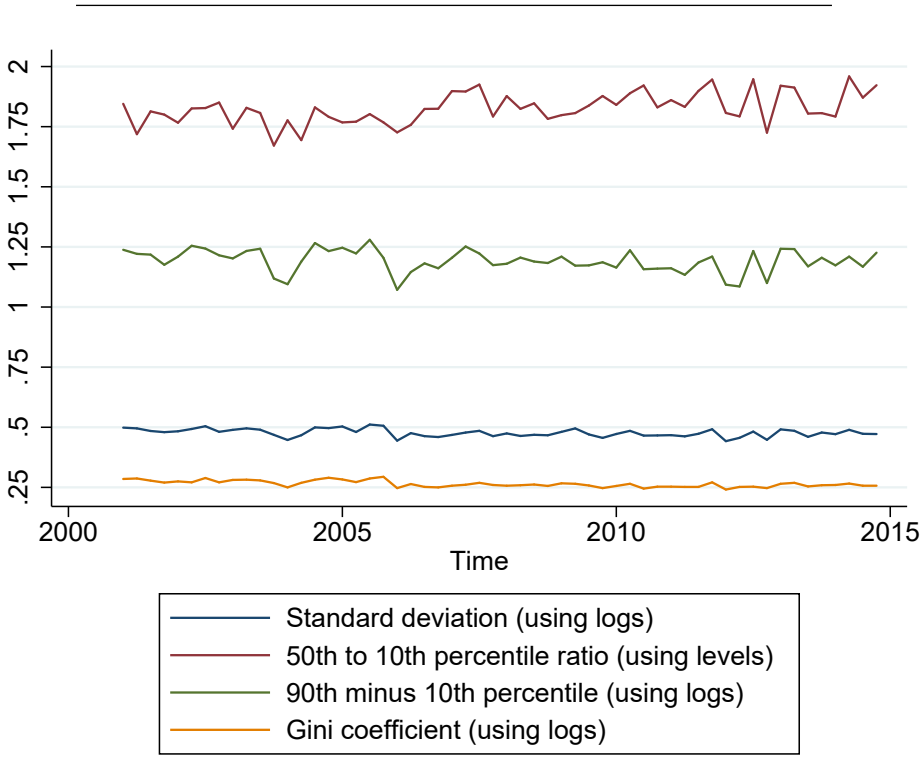
Figure 15: Distribution of saving rates, by housing tenure

Table 30: Household financial situation

	Age < 40		Age ≥ 40	
	Renters	Mortgagors	Renters	Mortgagors
Strong improvement	21%	19%	9%	9%
Weak improvement	31%	31%	21%	26%
Stagnation	23%	25%	35%	36%
Weak deterioration	16%	18%	23%	22%
Strong deterioration	9%	8%	13%	8%

Sources: HABE (SFSO). *Notes:* Answers to the question about the financial situation in the HABE are available for 7,328 renters and 5,865 mortgagors between 2001Q1 and 2005Q4. The interviewee is asked how the financial situation of the household is compared to last year. The reported numbers may not add up to 100 due to rounding errors.

A.6 Responses of inequality



Notes: We plot three measures for the inequality of households' non-durable consumption expenditure by quarter. Consumption is expressed in units of prices in 2007Q4 and adjusted for household size. We use the logarithms of consumption to compute the standard deviation and the 90th-10th percentile difference; and we use consumption levels to compute the Gini coefficients and the 90th-50th percentile ratios. These different measures allow easy comparison with the literature mentioned in the main text.

Figure 16: Inequality of non-durable consumption in Switzerland over time

Table 31: Regression output: Non-durable consumption inequality

	(1) Std. deviation	(2) P(50)-P(10)	(3) P(90)-P(10)	(4) Gini coefficient
Futures shock (3M): sum Q(-1:-4)	-0.00069	-0.00106	0.02828	0.00294
	(0.00984)	(0.04060)	(0.02928)	(0.00760)
Futures shock (3M): sum Q(-5:-8)	0.00309	-0.01878	0.01743	0.00584
	(0.01036)	(0.04275)	(0.03083)	(0.00800)
Futures shock (3M): sum Q(-9:-12)	-0.00817	-0.05153	-0.00054	-0.00091
	(0.01004)	(0.04141)	(0.02986)	(0.00775)
Constant	0.47375***	1.81478***	1.19608***	0.26394***
	(0.00532)	(0.02197)	(0.01584)	(0.00411)
Observations	48	48	48	48
R^2	0.028	0.039	0.027	0.019

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are the measures for the inequality of household-level non-durable consumption, computed per quarter in the time period 2003Q1-2014Q4. Consumption is expressed in units of prices in 2007Q4 and adjusted for household size. We use the logarithms of consumption to compute the standard deviation and the 90th-10th percentile difference, and we use consumption levels to compute the Gini coefficients and the 90th-50th percentile ratios. This is to make our numbers comparable to the literature. Standard errors are reported in brackets.

A.7 Data appendix

The German Socioeconomic Panel (GSOEP) and the Swiss Household Panel (SHP) are unbalanced household panels. Households are interviewed once a year. The GSOEP covers all German households since 1990 whereas the SHP starts in 1999. We use the data on households since 2000, the time period for which we have constructed the series of monetary policy shocks.

For both the GSOEP and the SHP, our constructed sample consists of households for which the following variables were recorded: housing tenure, age, household size, number of children, income, education years, civil status and region. We keep households whose interviewee is the household head (or partner), and drop duplicates (i.e., when the partner also answered separately). We only consider household heads with an age of 24 and older, an age at which most households have finished full-time education and have entered the labor market. We thus drop 9.6% and 13.9% of the observations in the initial data sets for the GSOEP and SHP, respectively. The constructed sample contains 159,079 and 46,498 households for the GSOEP and the SHP. The samples reported in the text and used for the regressions are smaller: 136,718 and 40,637 respectively. This is because of the lagged values of the shocks, which are not available for households at the beginning of the sample period.

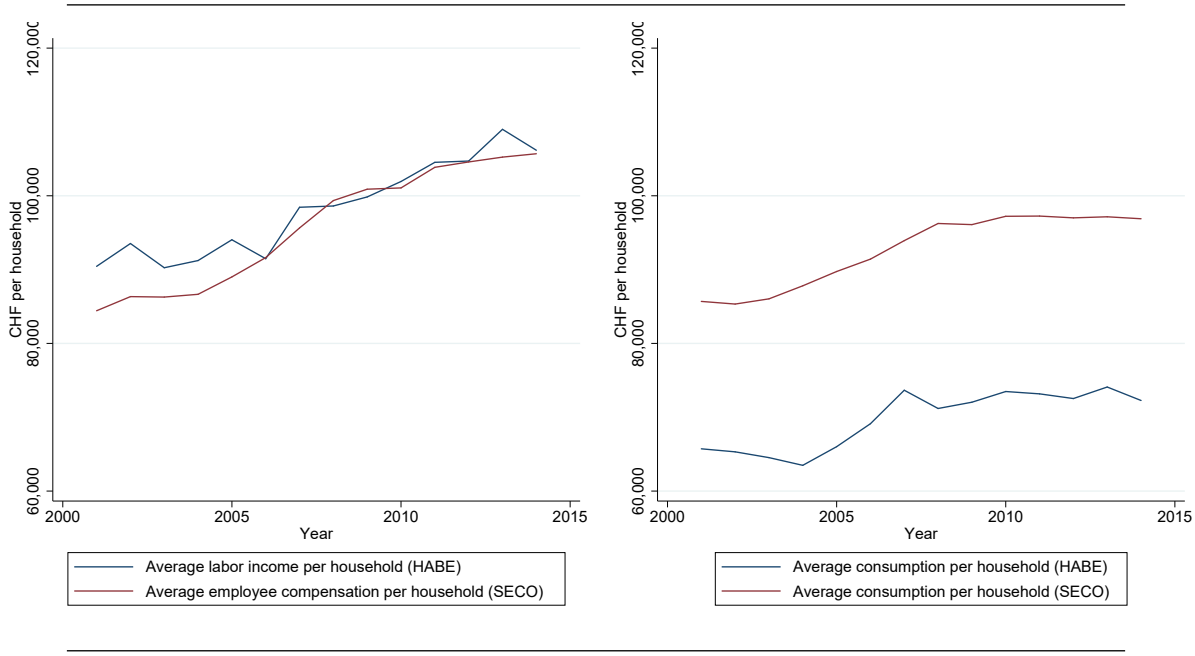
The Swiss household budget survey (*Haushaltsbudgeterhebung* or HABE) is a repeated cross-sectional data set that interviews households since 2001. It contains data on detailed household income and expenditure items between 2001Q1 and 2014Q1 and is used for the national CPI calculations. We construct the variables based on the HABE as follows.

Labor income contains both salary payments for the employed and income for the self-employed.[26] Our measures of nondurable and durable expenditures follow closely that of Cloyne et al. (2017). *Non-durables* include the following categories: food and non-alcoholic drinks, tobacco and alcoholic drinks, food and accommodation services, clothes and shoes, nondurable household goods, utilities, health services, motoring nondurable expenditure and gas, communication services, nondurable leisure items and services, culture services, other nondurable goods and services. *Durables* include the following categories: cars, bikes, motorised bikes, durable household goods (fridges, furniture, electric apparels), eletronic durables (IT, photo and audio-visual equipments), durable leisure goods, jewellery and watches. We define a household as a *mortgagor* when the household owns the primary home and pays mortgage interest for it.

We adjust the budget items for household size, using the equivalent scale of Fernandez-

[26] Income for the self-employed consists of the sum of all transfers from the owned firm to the household. For limited and partly limited companies, this takes the form of an individual declared salary. For firms with full liability, all private transfers are included (this includes personal invoices paid via the firm).

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). In the HABE dataset only 1% of households contain more than five persons. The monetary variables are then expressed in units of prices in 2007Q4, using the final consumption expenditure deflator from the SECO (Data, Table *qnaqcsa*, *ESA*, Reference *deflq*, *P.3*).



Sources: HABE, SECO, SFSO. *Notes:* Data from the national accounts are converted into averages using the SFSO household count which we linearly interpolate for missing years. The consumption data from the SECO contain expenditure of households and non-profit institutions serving households (NPISHs).

Figure 17: Comparison of labor income and consumption in the HABE dataset with aggregates from the national accounts

The constructed sample consists of households for which the following variables are recorded: housing tenure (renting or owning the primary home), age, expenditure on both nondurables and durables, rent/mortgage interest payments and net income. Net income is the sum of labor income, wealth income and transfers (social transfers and pensions) net of taxes. We keep households with a positive net income, i.e., households who have *some* resources available (only 390 households are thus dropped). Analogously to the construction of the GSOEP and SHP samples, we keep households whose interviewee is the household head (or partner) and drop duplicates (i.e., when the partner also answered separately). We consider household heads aged between 24 and 75 years, as in Cloyne et al. (2017), and we keep those households who report some durables' expenditure and housing expenditure (all households report some expenditure on non-durables). We are thus left with 75.6% of the observations in the initial data set and our constructed sample

contains 36,785 households, of which 30,807 are used in the benchmark specification due to the use of lagged shocks that are not available for households at the beginning of the sample period.

In Figure 17, we compare the average labor income and consumption in the HABE with the respective averages obtained by dividing employee compensation and consumption from the national accounts, available from the SECO, by the number of households based on the SFSO's household count. The series for average labor income are remarkably similar for the two datasets. Average consumption in the HABE is not comparable with the series based on the national accounts because the final consumption expenditure reported by the SECO includes expenditure by non-profit institutions serving households (NPISH) such as sports clubs or churches. Although the level of average consumption is thus smaller in the HABE dataset, Figure 17 shows that the behavior of consumption over time is very similar for both data series. Overall, this comparison suggests that the survey data in the HABE is meaningful so that we use it in our regression analysis in Section 6.

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