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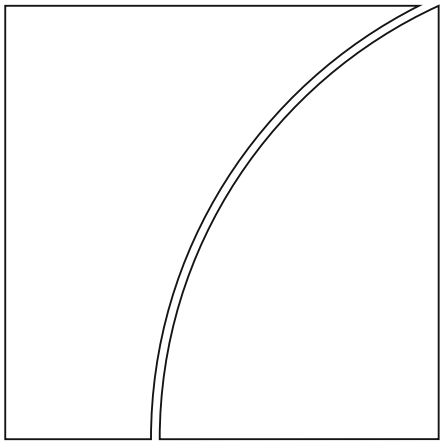

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Monetary and Economic Department

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The causal effect of house prices on mortgage demand and mortgage supply: evidence from Switzerland[1]

Christoph Basten[2] and Catherine Koch[3]

Abstract

We identify the causal effect of house prices on mortgage demand and supply in Switzerland by exploiting exogenous shocks to immigration and thereby to house prices. Detailed micro data on individual requests and offers allow to close down possible other channels. We find that within the same interest rate environment 1% higher house prices imply 0.52% higher mortgage amounts. The full partial correlation of 0.78% suggests also positive feedback from mortgage volumes to house prices. While we find higher house prices to increase mortgage demand, banks respond if anything with fewer offers and higher rates, especially later in the boom and for highly leveraged households.

Keywords: House prices, Mortgage demand, Mortgage supply, IV

JEL classification: D14, G21, J61, R21

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1. Introduction

Recurrent real estate and mortgage market booms have shown that surging house prices and mortgage market expansions tend to coincide. This has been the case in the US subprime boom as well as in recent real estate booms in Spain, Ireland and other Eurozone economies. It also applies to more recent booms in amongst others Norway and Switzerland.[4] Yet the direction and channels of causality between house prices and mortgage markets remain largely unclear.

We identify the causal effect of house prices on mortgage demand and supply. We combine two strategies to obtain variation in house prices that is exogenous to the mortgage market. First, we instrument house prices with "Origin Push Immigration" (OPI). OPI is that part of immigration, which is triggered by push factors in immigrants' countries of origin, rather than by pull factors at their destination. This type of instrumental-variable (IV) strategy, which is also known as "shift-share strategy" has previously been used to identify the effect of immigration on housing prices, first by Saiz (2007) and later by, amongst others, Fischer (2012), Gonzalez and Ortega (2013), and Accetturo et al. (2014). However, we are the first to exploit the implications of the immigration house price link to identify in turn the effect of house prices on the mortgage market. Second, we use not only year-by-month[5] but also canton fixed effects and thus focus on variation between different neighbourhoods located within the same labour market and public policy environment. This strengthens further the plausibility of our exclusion restriction. Furthermore, while previous shift share papers had to rely on aggregate data, we use micro data on individual mortgage requests and offers, and control for detailed applicant and object characteristics.

In addition to identifying the causal effect of house prices on the requested mortgage amounts, our setup also allows us to differentiate between the effect on mortgage demand and that on mortgage supply. This is because in our setup demand cannot be influenced by *request-specific* supply, which is set only afterward, while *aggregate supply* is controlled for by year by month as well as canton fixed effects. Potential direct effects of demand on request-specific supply by contrast are investigated by an augmented Simultaneous Equations Model in the Appendix and is not found to play a significant role after controlling for our extensive set of request characteristics.

We find that a 1% higher house price implies a 0.52% higher mortgage amount. The non-causal partial correlation between house prices and mortgage demand however amounts to 0.78%, suggesting also positive reverse causality from mortgage amounts to house prices. This points at a mutually reinforcing mechanism between real estate and mortgage market booms and busts. However, the coefficient size below unity implies that higher house prices lead to lower loan-to-value (LTV) ratios, thus confirming previous findings in Ono et al (2014), FSA (2009) and SNB (2015). Furthermore, higher house prices are not found to induce lenders in our sample to expand mortgage supply: Instead, lenders make – if anything – ceteris paribus fewer offers and charge higher risk premiums the higher the house price. This cautious

[4] For more examples, see IMF (2011) and Igan and Loungani (2012).

[5] The year-by-month fixed effects control fully for the prevailing interest rate environment. Thus this paper does not analyse the effect of the low interest rates on house price and mortgage volume growth, which has been shown in other studies such as Hott and Jokipii (2012).

lending behaviour is particularly pronounced in the second sub-period of our sample. During this period house prices have already gone through an extended period of growth and hence are more likely to be overvalued. The caution is also particularly pronounced for mortgage requests with high LTV ratios, but does not depend on the request's payment to income (PTI) ratio. It is also more pronounced for applicants requesting adjustable rather than fixed rate mortgages.[6]

The remainder of the paper is structured as follows: Section 2 first covers different theories of how real estate prices, mortgage demand and mortgage supply could be causally related, and then provides a brief summary of the as yet limited evidence on the topic. Following this, Section 3 introduces our data and Section 4 our empirical strategy. Section 5 presents the results, including a summary of the detailed robustness checks presented in our Appendix. Section 6 concludes.

2. The link between house prices and mortgage volumes

2.1 Theory

We investigate the causal relationships behind the correlation between house prices and mortgage volumes for the case of Switzerland. Figure 1 illustrates this correlation by displaying the annual growth rates of respectively residential rents, apartment prices, single-family home (SFH) prices, and mortgage volumes for the years 1971-2013. While there are also idiosyncratic factors at play, the growth rates clearly appear correlated. As for timing, it would if anything appear that mortgage volumes slightly lag house prices, although any such observation must at this stage remain tentative given the small number of observations. To shed light on the potential causal relationship between house prices and mortgage volumes, the literature offers three major hypotheses. We sketch these in blue in Figure 2.

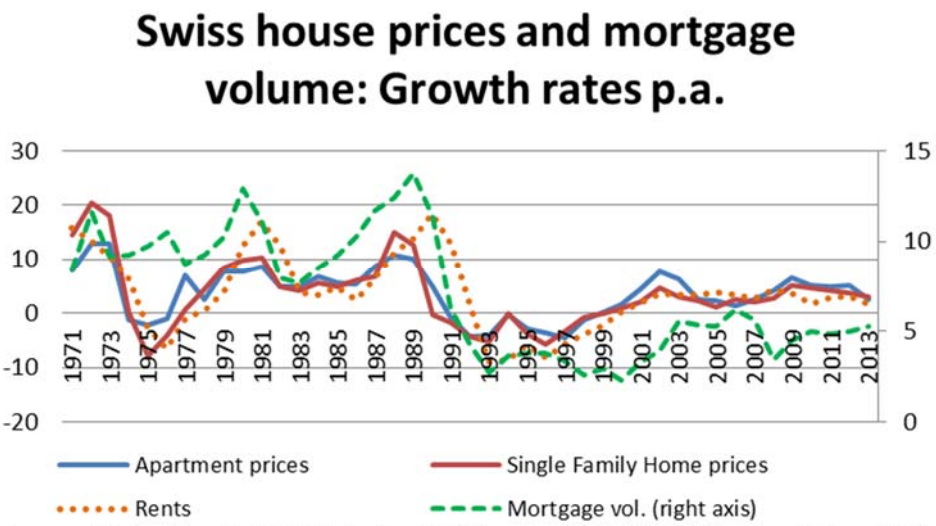
First, there may be a positive causal effect running *from house prices to* the mortgage market via mortgage *demand*: When house prices have grown faster than household financial wealth, households need to demand larger mortgages as they cannot finance the increased cost for a given size and quality of housing only out of their savings. In addition, amongst households looking at housing as an investment rather than solely as a consumption good, higher current house prices may furthermore trigger expectations of prices staying at current levels or increasing even more. Conditional on their balance sheets and regulatory requirements[7], banks[8] may satisfy increased mortgage demand, but only in return for higher risk premiums and hence higher mortgage rates. Higher mortgage demand does then result in higher equilibrium mortgage amounts, also absent an outward shift in the mortgage supply curve.

[6] Robustness checks show that results are similar when we use observations on all lender responses rather than just one observation per request and include in addition to all other controls also lender fixed effects.

[7] See Section 3.1 on Swiss mortgage market regulation during the period studied.

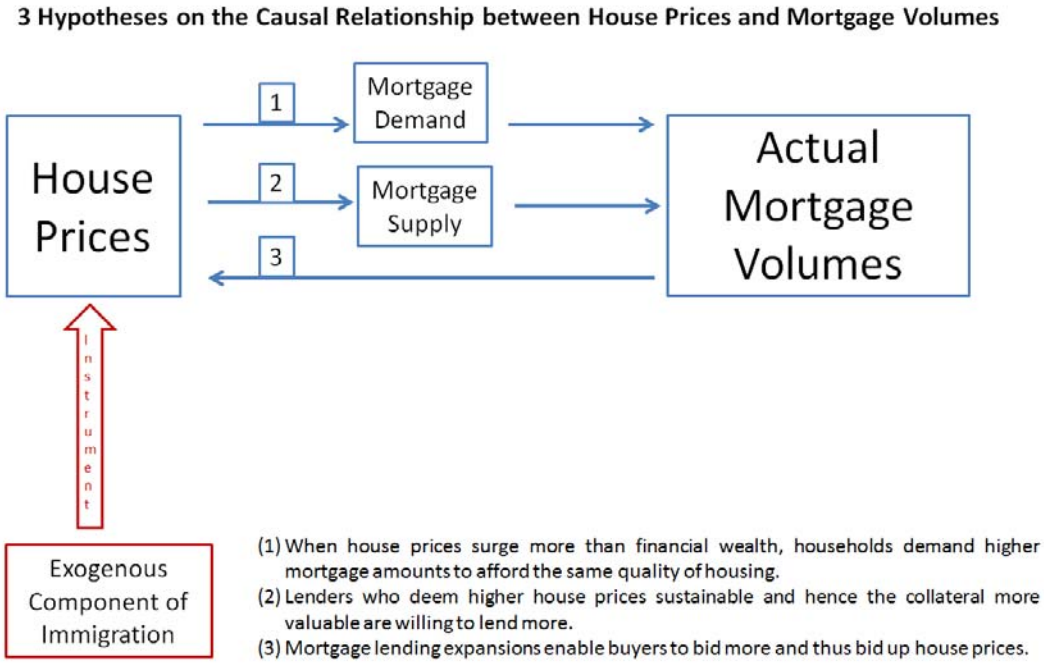
[8] In our empirical setup, some mortgages are offered by insurance companies. Our results do not hinge on whether or not we include insurers, since they hold only about 5% of the market (See FINMA, 2014). For simplicity, we shall nonetheless use the terms "banks" and "lenders" interchangeably. Further, we shall often write "house" for both houses and apartments.

Swiss house prices and mortgage volume: Nominal growth rates per annum Figure 1



Sources: SNB Stat. Monthly, T. Q4.3 (prices) and D1.1 (mortg. vol. 1988 ff.), SNB Hist. Data (MV pre-1988)

Three different causal relationships between house prices and mortgage volumes Figure 2



Second, house prices may also exert a positive causal effect on mortgage *supply*: If banks deem higher house prices sustainable and hence the collateral more valuable, they may be willing to lend more.[9] Thus Igan and Loungani (2012) write: "Real estate plays an important collateral role and lenders tend to become more willing to extend

[9] So an appreciation in collateral may relieve household liquidity constraints. For details on the role of liquidity constraints for household consumption, see Basten et al (forthcoming) and Basten et al (2014a).

loans when collateral values increase". This follows the idea of the "Financial Accelerator" literature, where changes in the value of the collateral affect borrowing capacity, see Bernanke et al. (1996) or Andrés and Arce (2012), and specifically for the housing market Almeida et al. (2006).

For recent increases in prices to raise the willingness to borrow or lend, prices only need to be expected to remain at their current (elevated) levels, but the mechanism is strengthened even further when recent increases lead to expectations of further increases, as modelled in Bruckner et al (2012) or as modelled and corrobarated empirically in Guren (2014).[10,11,12]

A third possible link between house prices and mortgage volumes runs in the opposite direction: from mortgage volumes to the housing market. Under that scenario, banks shift the mortgage supply curve by making a larger share of applicants an offer or by offering more attractive mortgage rates. The resulting easier access to mortgages allows more potential home buyers to enter the market for owner-occupied property, and allows each of them to afford a more expensive house, thereby bidding up house prices. Thus Geanakoplos (2010) presents a model in which some buyers are more eager to buy a house and so have a higher reservation price than others. If these buyers are extended enough credit, equilibrium house prices will be higher than if some of the most eager buyers are kept out of the market. In an extension of this work, Fostel and Geanakoplos (2012) show how leverage and tranching first raised US house prices, and the introduction of Credit Default Swaps then lowered them.

The relative importance of each of these channels is likely to depend also on the regulation in place, in particular on LTV and PTI requirements as well as on taxation. In particular, when many households can afford the desired property only by putting all available equity on the table plus taking out the maximum permissible loan, then any increase in house prices must be financed entirely by increasing the loan amount. In the Swiss context, LTV ratios are indeed sanctioned: While no LTV ratio is strictly forbidden, regulatory capital requirements provide some incentives related to LTV ratios: Thus tranches above the LTV thresholds of respectively two-thirds and 80% receive higher risk-weights (respectively 75% and 100% instead of 35%), implying higher capital requirements and therefore (unless the Modigliani Miller theorem holds perfectly) higher costs. Furthermore, since July 2012, the entire mortgage will receive a risk-weight of 100% if its LTV ratio exceeds 90%, see Basten and Koch (2015a) for details. However, at the same time tax incentives motivate households to choose a lower down payment than they could afford given house price and financial wealth and invest the remaining savings in other assets. Therefore, in terms of

[10] Alternatively, careful banks may instead respond to higher house prices by *restricting* the mortgage amounts and PTI ratios or by charging *higher* risk premiums. This alternative behaviour would *reduce* rather than increase pro-cyclicality.

[11] Relatedly, Ebner (2013) shows that expectations of future house price increases may encourage higher borrowing against the house not only for the house purchase, but also for other purposes via home equity withdrawals. Barakova et al. (2014) show that for home owners wishing to move the impact of recent price increases on their borrowing capacity is ambiguous, depending on whether the area they move to has seen stronger or weaker price increases than the one they come from.

[12] Caldera and Johansson (2013) show that house price increases affect not also mortgage markets, but also feed back to the supply of housing, although this mechanism is found to be more pronounced in the US and the Nordic countries than in Continental Europe. Such feedback is likely to moderate the positive momentum of house price increases and thus counteract to some extent the accelerator caused by a positive two-way causality between house prices and mortgage volumes.

comparative statics with an increase in house prices, households should still have leeway to put more equity on the table and therefore finance only part of the additional cost by increasing their mortgage amount. This is so in particular when the hedonic price estimates banks use to compute LTV ratios for risk management and regulatory purposes (and which we do not observe) increase less than the LTV ratios based on actual purchasing prices (which we do observe and use in our estimations). Furthermore, the effect of house prices on mortgage amounts may be subdued when PTI requirements are or become binding, i.e. when regulation sanctions (through higher capital costs for lenders) higher mortgage amounts for given household incomes. In Switzerland during the period studied no such PTI requirements were in place.

On top of the three possible causal relationships discussed above, both house prices and mortgage volumes are of course also exposed to other economic developments. A particularly important factor influencing simultaneously house prices and mortgage volumes are interest rates. *Low interest rates* may increase mortgage demand, as they make larger mortgage amounts affordable. At the same time, low interest rates may diminish the risk-adjusted returns that lenders can earn on other assets and hence increase their willingness to supply mortgages. In our empirical setup we implicitly control for the effect of interest rates by way of monthly fixed effects, so interest rates do not distort our findings. We caution however, that this does not preclude an effect of interest rates on house prices in the macro economy. Another possible source of noise in a setup like ours is *income growth*. Thus in some past booms there has been feedback from house prices to mortgage demand via income levels in the construction sector. In the Swiss setup investigated though this is not the case: In the period under consideration, wages grew very slowly at about 1.3% p.a., and far more slowly than house prices (about 5% p.a.). In particular, the median wage in *construction* did not grow faster than the average wage. Furthermore, despite the house price boom the share of workers employed in construction has remained constant at about 8%. In our setup any other macroeconomic developments are in any case controlled for by canton, monthly fixed effects, as explained in more detail below.

Another possibly idiosyncratic shock to house prices however arises from population growth and in particular immigration. Figure 2 illustrates immigration as an idiosyncratic shock to house prices by means of a red arrow. We explain below which components of immigration may – under which conditions – indeed be considered as idiosyncratic or exogenous, i.e. as having a direct effect on house prices but not on mortgage volumes.

Understanding the relative importance of different causal links between house prices and mortgage volumes is not only of scientific interest. It is also crucial to design appropriate policy measures: If causality runs mainly from mortgage lending to house prices, then policy measures targeting the mortgage market should be able to effectively address both mortgage and house price growth. Things differ if observed growth rates result from a shock to house prices that is in turn exogenous to the mortgage market: Then mortgage market measures may slow down credit growth, but house prices may still keep growing, financed to a larger extent by household equity.

Of similar importance is an understanding of whether any positive effect of house prices on contracted mortgage volumes operates predominantly by increasing mortgage demand or by increasing mortgage supply. In the former case, demand-

side measures should take centre-stage. These may include changes to the tax deductibility of mortgage debt or restrictions on the LTV or PTI ratios with which households can apply for a mortgage. In the latter case by contrast policy-makers may wish to increase banks' marginal costs of mortgage lending, e.g. by use of higher capital requirements.[13]

2.1 Existing empirical evidence

We are aware of three papers that have used some form of instrumental variable methods to empirically tackle the two-way causality between house prices and mortgage volumes. First, Adelino et al (2012) *instrument mortgage supply* in the US with annual changes in the conforming loan limit, the maximum loan amount with which a mortgage can still be purchased and securitized by the US government-sponsored enterprises (GSEs). They find that houses which become eligible for a conforming loan end up costing $1.1 or 0.5% more per square meter. They conclude that access to cheaper funding was a significant driver of the US subprime bubble, even if it cannot fully account for the price increases. Second and similarly, Favara and Imbs (2015) exploit post-1994 US branching deregulation to compare mortgage origination of regulated and hence affected lenders to that of independent mortgage lenders. They find that the increase in mortgage supply attributable to branching deregulation raised annual house price growth by up to three percentage points. Third, Mian and Sufi (2011) approach the same two-way causality issue *from the real estate side*, instrumenting house price *growth* with differences in land scarcity across different US Metropolitan Statistical Areas (MSAs). They show that for every dollar in house price appreciation home owners extract an extra 25 cents in home equity. These three papers jointly draw a picture in which the US subprime bubble has mainly been triggered by an increase in the supply of mortgage lending. This in turn was caused by lenders' increased ability to rate and securitize their mortgages, as well as by a huge inflow of capital into the US. Once this increase in mortgage lending had caused house prices to increase, the ability to borrow against these higher values then further accelerated mortgage growth.[14] Whether the "second-round borrowing" effect of house prices on borrowing operated mainly by making borrowers more confident to borrow or by making lenders more confident to lend is left open by the existing research. However, the US subprime bubble emerged from the interplay of factors that to a significant extent seem specific to the recent US context, in particular the huge-scale securitization. It is therefore interesting to widen the focus from that specific boom and analyse another in which there is little securitization and little foreign bank refinancing.[15]

[13] Crowe et al. (2011) provide a detailed discussion of the advantages and disadvantages of different policy instruments. Kuttner and Shim (2013), using a panel of 57 countries and more than 3 decades, find specifically that demand side measures and in particular PTI limits have a larger effect on mortgage expansions than supply side measures, and only tax policies can robustly affect house prices.

[14] By contrast Justiniano, Primiceri and Tambalotti 2013, using a quantitative dynamic general equilibrium model, argue that the US boom is more likely to have been caused by factors that impacted house prices directly and then affected mortgage lending through the collateral channel.

[15] Gerlach and Peng (2005), Coleman (2008) Oikarinen (2009a), Oikarinen (2009b), Gimeno and Martinez-Carrascal (2010) and Anundsen and Jansen (2013) have addressed the two-way interaction between house prices and mortgage lending in respectively Hong Kong, the US, Finland (both

3. Context, data and descriptive statistics

3.1 Context: the Swiss real estate and mortgage markets

Ownership rates in Switzerland have historically been low, at about 30% until 1990, but in recent years they have increased to now close to 40 percent. Both house prices and mortgage volumes exhibited high growth rates in the late 1980s, negative rates in the early 1990s, and then again relatively high rates of around 5% p.a. since about the year 2000, see Figure 1. One distinguishing feature beyond the low ownership rates is its tax system: Swiss households pay taxes also on imputed rents, but can deduct interest payments from their taxable income also for owner-occupied real estate. This system is meant to be neutral between owning and renting, but it has the side effect of encouraging very slow amortization: Rather than amortizing their mortgage, Swiss households invest more savings in other asset classes. As a consequence, Swiss mortgage debt as a percentage of GDP is now one of the highest in the world. To contain the potential risks ensuing from this high (gross) indebtedness, the banking supervisory authority FINMA and the central bank SNB took two sets of measures during the period of study: First, in summer 2011 and 2012 FINMA declared new self-regulation by the Swiss Bankers Association as binding for all Swiss banks. This self-regulation required a minimum down payment worth at least 10% of the house value, and it required households to reduce their LTV ratios to 2/3 within at most 20 years of purchasing their house. Second, in February 2013 the SNB activated the "Counter-Cyclical Capital Buffer" (CCB) of Basel III, requiring banks to hold extra equity capital worth 1% of their risk-weighted assets secured by domestic residential property. For more details on these regulatory changes and their effects, see Basten and Koch (2015a). More importantly, these changes do not affect the results of this study, as we use monthly fixed effects.

3.2 Data

Our main data stem from the Swiss online platform *Comparis*. For a fee of CHF 148 (about USD 160), households can apply online for a mortgage in order to simultaneously receive offers from different participating lenders. Applicants can request different mortgage maturity models as listed in Table 1, Panel B, including one with rates fixed for between 1 and 10 years, rates tied to the LIBOR or rates than can be freely adjusted by the bank. With their request, households must submit comprehensive information on the property as well as on their personal finances. Lenders then decide whether or not to make an offer, and in the former case at what rate. They cannot reduce the amount. Hence LTV and PTI ratios are chosen by applicants. Offers are conditional on the subsequent verification of the submitted information. This together with the participation fee gives households an incentive to submit only serious requests with correct information. For applicants, paying the fee means to save the time to personally inquire with each of the banks individually. Furthermore, lenders know that applicants simultaneously receive offers from many different lenders, so lenders have an incentive to make a competitive offer.

Oikarinen papers), Spain and Norway using time series methods. Overall their findings are mixed. See Anundsen and Jansen (2013) for the most recent discussion as well as for further references.

Sample composition

Table 1

		Observations	Percentage of the Sample
(A)	By Year		
	2008	2,599	20.38%
	2009	2,808	22.02%
	2010	2,587	20.29%
	2011	1,627	12.76%
	2012	1,746	13.69%
	2013 (Jan-Oct)	1,386	10.87%
(B)	By Model		
	Rate Fixed for 1 Year	36	0.28%
	Rate Fixed for 2 Years	194	1.52%
	Rate Fixed for 3 Years	582	4.56%
	Rate Fixed for 4 Years	179	1.40%
	Rate Fixed for 5 Years	3,332	26.13%
	Rate Fixed for 6 Years	282	2.21%
	Rate Fixed for 7 Years	494	3.87%
	Rate Fixed for 8 Years	663	5.20%
	Rate Fixed for 9 Years	59	0.46%
	Rate Fixed for 10 Years	4,562	35.77%
	Variable Rate	641	5.03%
	Rate Libor-pegged for 3 Years	553	4.34%
	Rate Libor-pegged for 5 Years	186	1.46%
	Combined mortgage for <5 Years	145	1.14%
	Combined mortgage for >=5 Years	79	0.62%
	Special mortgage	766	6.01%
(C)	By Object type		
	Penthouse	356	2.79%
	Semi-Detached House	1,232	9.66%
	Apartment	3,565	27.95%
	Single Family Home	4,957	38.87%
	Multi Family Home	977	7.66%
	Town/Row/Terraced House	1,141	8.95%
	Terrace House	206	1.62%
	Mansion/Bungalow	319	2.50%

Special models include those with interest rate discounts for respectively energy-efficient buildings and large families, as well as "step" mortgages with lower initial rates.

Sources: Comparis

For the purpose of our research, the *Comparis* data have a number of advantages. First, we observe for each mortgage request many details on both demand and supply. On the demand side these include the characteristics of the requested mortgage, details of the house to be financed, as well as of the financial situation of the applying household. On the supply side, we observe which banks respond with

an offer and which rates they offer. Second, observing many offers for the same request allows us to distinguish between the causal effects of house prices on mortgage demand and those on mortgage supply. Third, we observe exactly the same set of details about the applying household (including age, income, wealth, liquid wealth, debt, and existing real estate holdings) and the real estate object to be financed (including postcode, age, type and market price) as potential lenders receive. Since customers apply anonymously online rather than by visiting lenders' local branches, banks have no further, private information.[16]

For the purpose of instrumenting house prices, we combine our micro level data with information on immigration into each of Switzerland's 106 statistical ("MS") areas defined by the Swiss Federal Office of Statistics. MS areas offer a finer grid than the 26 cantons (states) or the 16 labour market regions (also defined by the BfS). From the Swiss Statistics Office we have obtained information on the total population, as well as on immigration for each calendar year and each MS area.[17] As explained in the empirical strategy section, we need information not only on the total number of immigrants, but also on immigrants' countries of origin. A matching key between MS areas and zip codes allows us to merge that immigration information to our main dataset.

3.3 Descriptive statistics and representativeness of our sample

Table 1 presents a first overview of our sample composition in terms of the years covered (Panel A), the mortgage model requested (Panel B) and the type of object to be financed (Panel C). It shows that our sample stretches from January 2008 until October 2013. Panel (B) shows that a bit over 80% of applicants ask for a fixed rate model, most of them with a maturity of either 5 or 10 years. About 5% have their mortgage rate pegged to the Swiss interbank rate (CHF Libor) and another 5% choose a model in which the bank may change the rate at its discretion, but where in return the household may at any time move from the variable to a fixed-rate contract without surcharge. With a view to the types of object to be financed, Panel (C) shows that the single largest groups are single-family homes (39%), apartments (28%), semi-detached houses (10%) and town houses (9%).

Table 2 and Table 3 an idea of how our sample compares to the full Swiss market. The majority of that market takes place off-line, but all mortgages for owner-occupied residential real estate are granted through private-sector lenders (95% banks, about 4% insurers, and the remainder pension managers) as opposed to for example government-sponsored enterprises. Our comparison draws First on SNB (2014), secondly on a survey conducted by Seiler (2013), and thirdly on the Household Budget Survey (HBS) of the Swiss Federal Office of Statistics. The SNB aggregate data give information about LTV ratios and geographical distribution of the *stock* of all mortgages listed on Swiss banks' balance sheets. Unfortunately it does not allow to

[16] For an example on how soft information matters in branch based consumer lending, see Puri, Rocholl and Steffen (2012). More specifically on the role of the breadth of the banking relationship in Switzerland, see Brown and Hoffmann (2013).

[17] For years 1995-2010 these stem from the "PETRA" database, afterwards from the "STATPOP" database.

Comparing the geographical distribution of our requests to those in the offline market

Table 2

(A) Sample vs. SNB Statistics of the distribution across cantons

	SNB Statistics	Sample	
	% of Volumes	% of Volumes	% of Number
	(1)	(2a)	(2b)
Zurich	19.19	26.58	23.70
Berne	10.77	12.21	13.66
Aargau	8.73	11.04	11.94
Vaud	8.07	10.00	9.19
St.Gallen	5.73	4.34	4.92
Geneva	5.06	3.74	2.67
Ticino	4.73	2.07	2.23
Lucerne	4.64	3.59	3.59
Basel Land	3.86	3.88	3.98
Valais	3.59	3.01	3.24
Thurgau	3.48	1.48	2.05
Solothurn	3.37	3.40	3.62
Graubünden	3.33	1.50	1.82
Fribourg	3.23	2.70	3.21
Schwyz	2.37	2.72	2.24
Zug	2.04	1.87	1.65
Basel Stadt	1.92	2.16	1.80
Neuchatel	1.53	1.08	1.25
Schaffhausen	0.94	0.76	0.87
Jura	0.75	0.31	0.42
Appenzell AR	0.62	0.43	0.54
Nidwalden	0.54	0.39	0.30
Obwalden	0.47	0.43	0.40
Glarus	0.44	0.38	0.43
Uri	0.40	0.17	0.20
Appenzell IR	0.18	0.07	0.07

(B) Comparison Sample vs. Seiler survey of the distribution across regions

	Overall	Pension-financed	Not pension-financed	% of Volumes	% of No
	(1)	(2)	(3)	(4)	(5)
Zurich	28.28	27	31	27.34	24.57
Eastern Switzerland	16	16	16	8.21	9.83
Mittelland	17.72	19	15	26.64	29.22
Northwestern Switzerland	13.36	14	12	13.14	13.90
Lake Geneva Region	10.36	11	9	13.74	11.86
Ticino	4.28	3	7	2.07	2.23
Central Switzerland	8	8	8	9.17	8.38

Notes: Panel (A) compares the distribution of mortgage lending across cantons (states) between the entire Swiss mortgage market in Column (1) and our sample in Columns (2) and (3), based on statistics from SNB (2014). Panel (B) compares the distribution across market regions between Seiler (2013) on the one hand and our sample on the other hand.

Sources: SNB, Seiler (2013) and Comparis.ch

focus specifically on mortgages granted recently during our sample period 2008-13. By contrast, Seiler (2013) allows to focus more closely on recently granted mortgages, but since the purpose of the survey was to compare real estate purchases financed with pension money to those financed without pension money, there is no guarantee that the survey itself is representative of the entire market. Finally, the HBS allows a benchmarking of our sample in terms of household income and wealth. Overall, these three sources are, to the best of our knowledge, the most suitable public data benchmarks. Table 2 shows that our data are drawn from all regions of Switzerland. Panel (A) might suggest a slight bias in favour of German-speaking cantons, but Panel (B) does not. Panel (A) also shows that we have slightly more requests from the canton of Zurich than would be expected on the basis of SNB data, however this may as well be due to SNB data being more backward looking (giving stocks rather than flows) and hence missing the fact that mortgage volumes in Zurich exhibited faster growth rates than those at the national average during the relevant period. Table 3 shows that our data are fairly representative in terms of LTV ratios. Finally, we can compare our summary statistics on household income to data from the HBS. In our sample we observe a mean household income of CHF 167'256, which may seem high to readers not familiar with Swiss income and price levels. However, in the HBS average income of home-owners starts at CHF 150'000 and may be as high as CHF 177'000 with 3 or more children, so the values in our sample are within the normal range.

Comparing LTV ratios in our sample with those in the offline market — Table 3

(A) Distribution across Loan-to-Value (LTV) brackets

	SNB Statistics	Sample
	(1)	(2)
LTV < 67	92.47	91.47
67 <= LTV < 80	5.66	7.83
LTV >= 80	1.87	0.70

(B) Mean and Median Loan-to-Value (LTV) ratios

	Seiler survey	Sample
	(1)	(2)
Mean	70.90	70.35
Median	73.50	75.00

SNB statistics are based on SNB (2012), the Seiler survey data on Seiler (2013), see bibliography. SNB statistics are only available for the stock of all mortgages on banks' balance sheets, we compare these with mortgages newly granted or rolled over during our sample period. The comparison with Seiler (2013) in Panel (B) focuses on new mortgages only.

Sources: SNB, Seiler (2013) and Comparis.ch

Thus our sample seems reasonably representative of the entire market on the demand side. Furthermore, the supply side of our sample contains 44 lenders from all major banking groups except for the two big banks UBS and CS[18], as well as four insurers. This gives quite a representative picture also of the supply side, because in the period considered mortgage volumes of the two big banks, for whom domestic

[18] These did not participate in the *Comparis* platform and are thus not observed by us.

mortgages are only one of many businesses, grew only half as fast as the market as a whole.[19][20]

Summary Statistics — Table 4

		Observations	Mean	Std. Dev.	P10	P50	P90
(A)	Key request figures						
	Requested Mortgage Amount (CHF)	12,753	586,933	348,282	250,000	500,000	1,000,000
	House Price (CHF)	12,753	939,855	571,636	455,000	795,000	1,600,000
	Loan-to-Value ratio (LTV ratio)	12,753	64.79	16.83	39	69	80
	Price-to-Income (PTI ratio)	12,753	26.33	10.39	14	26	37
	Request for a new Mortgage in % (Indicator)	12,753	52.31%				
	Amount of the Previous Mortgage (for roll-overs)	6,082	527,104	450,614	227,000	449,540	830,700
(B)	Key applicant and object figures						
	Household Income (CHF p.a.)	12,753	167,256	91,417	85,000	146,000	270,000
	Household Liquidity (CHF)	12,753	168,997	216,317	16,500	100,000	400,000
	Household Debt in % (Indicator)	12,753	19.96	39.97	0	0	1
	Household owns real estate in % (Indicator)	12,753	27.57	44.69	0	0	1
	HH wealth incl retirement savings	12,753	511,768	924,411	95,000	315,000	1,022,000
	Applicant age	12,753	46.05	10.23	34	45	61
	House age in decades	12,753	2.49	3.57	0	1	7
(C)	Immigration into MS Areas						
	Origin Push Immigration / Population (1995 shares)	12,753	1.33%	0.82%	0.67%	1.07%	2.72%
	Origin Push Immigration / Population (2000 shares)	12,753	1.34%	0.83%	0.60%	1.07%	2.61%
	Origin Push Immigration / Population (2008 shares)	12,753	1.36%	0.87%	0.58%	1.08%	2.62%
	Actual Immigration / Population	12,753	1.36%	0.85%	0.59%	1.07%	2.71%
(D)	Offers						
	Offers per Request	12,753	5.41	2.55	2	5	9
	Best Interest Rate Offered	12,753	2.31	0.76	1.25	2.25	3.35
	Median Interest Rate Offered	12,753	2.54	0.76	1.56	2.49	3.57

Notes: Best and median interest rate: amount-weighted average across tranches.

Sources: Comparis and Swiss Federal Office of Statistics

Table 4 then provides the more detailed summary statistics, starting in Panel (A) with the key figures on the mortgage requests. We see that the average mortgage amount requested was about CHF 587,000 and the mean house price to be financed about CHF 940,000. The LTV ratio amounted on average to 65%. Another common

[19] Based on data from SNB (2013b), which only allows to infer net growth of mortgage volumes (i.e. new issuance minus volumes repaid), the total market grew by about 4.6% whereas the volumes held by the two big banks grew by 2.3%. As a result, the *two big banks accounted for merely about 13% of the net increases* in the total mortgage volume.

[20] In Switzerland no mortgage lending is done by government-run enterprises.

indicator of a mortgage's riskiness is the PTI ratio, the percentage of regular annual income that a household would have to spend on debt service for the suggested object, given a conservatively chosen interest rate. *Comparis* computes this for the participating lenders assuming a mortgage rate of 5%, amortization worth 1% of the mortgage amount only for borrowers with initial LTV ratios above two-thirds, and maintenance costs worth 1% of the house price. Setting these payments in relation to regular annual income yields a PTI ratio with a mean of about 26%. This mean lies somewhat below the 33% rule-of-thumb threshold above which the PTI would typically be deemed problematic, but about 23% of requests have PTI ratios at or above that threshold (not shown in the table).

About 52% of the requests concern new mortgages, the remainder re-financings. This occurs because Swiss mortgage contracts typically envisage a period of several years during which neither side can leave the contract without incurring an additional fee. In fixed rate contracts this corresponds to the period for which the mortgage rate is fixed. At the end of that period, households typically do not repay their mortgage but they may shop around to see if another lender offers a better deal. The average amount requested for refinancing deals (not displayed separately) was about CHF 509,000. That new amount for refinancing requests was higher than the initial mortgage in 12% of cases, lower in another 12%, and identical in the remainder of cases. The differences between new and refinancing mortgages are investigated and discussed further in the results section.

Panel (B) features further information on the applying households. It shows that average *household income* is around CHF 167,000 p.a. and average *liquid wealth* lies slightly above one year's income, at CHF 169,000. Close to 20% of households hold some form of other debt and about 28% already own some other real estate. The mean value of households' total wealth including pension wealth is about CHF 512,000 and the average age is about 46. The average age of the houses is 2.5 decades, but half of the objects are 10 or fewer years old. Panel (C) covers immigration. It shows that both actual annual immigration and different variants of the instrument explained in more detail in the empirical strategy section amounted to between 1.33% and 1.36% of the previous year's resident population. In all cases we are forced to use gross rather than net migration, because data on the outflow of foreigners mix true outflows with naturalizations. Furthermore, note that the panel on immigration reflects the distribution across our 12'753 mortgage requests, as they enter our estimations, and not an equal or exactly population weighted average across all 106 MS areas. Panel (D) finally looks at the supply side. It tells us that the average applicant in our sample receives 5.4 different offers. The best interest rate offered across all models did on average amount to 2.31% and the median one to 2.54%.

4. Empirical strategy

Estimations of the causal effect of house prices on mortgage demand and supply may suffer from reverse causality as increases in mortgage volumes are likely to in turn affect house prices. We exploit house price shocks exogenous to the mortgage market, by using variation in the exogenous component of immigration, within cantons or labour market regions and within a given year and month. In the following subsections, we explain in several steps what we mean by the exogenous component

of immigration and which crucial role our set of fixed effects and further controls at the applicant level play.

4.1 Immigration as an instrument for house prices?

Immigration by area and period is likely to already constitute a decent instrument for house prices[21]: While there is likely to be *reverse causality* from mortgage volumes to house prices, mortgage lending would seem less likely to directly affect immigration and thus cause *reverse causality* problems of its own. This is particularly true for Switzerland, where various studies show that immigrants themselves typically do not buy real estate and especially not *in the year of arrival*. Rather, immigrants affect house prices only indirectly: As immigrants push up rents, more natives decide to buy a house. This increased demand for owner-occupied housing faces housing supply that is inelastic, in particular in the short run, and therefore pushes up house prices. Indeed Figure 1 shows that in our sample period growth rates of rents and house prices have very much moved in parallel.

A study by the Swiss federal agency for housing, Bundesamt für Wohnungswesen (2007), corroborates this: using data from the Swiss Labour Force Survey SAKE, the authors find that as of 2006 on average 51% of Swiss citizens live in their own home, but only 10% of new immigrants do (Table 22, page 70), although the ownership share of immigrants does increase somewhat with the length of their stay. A similar picture emerges specifically for the canton of Zurich in Rey (2011) and Rey (2012). Besides, the share of immigrants living in owner-occupied property is likely even lower in those agglomerations where immigration is highest because immigrants are likely to stay shorter in a residence than natives. Concerns about reverse causality from the mortgage market and more specifically the real estate market on immigration flows are diluted further by data on employment, showing that despite the house price boom the share of workers employed in construction has remained constant over the period under consideration, as has the share of foreigners amongst them. This refutes the possible concern that booming housing markets may have attracted many construction workers from abroad, as happened for instance during the Spanish house price boom in the early years of European Monetary Union.

Yet, there is a remaining concern that total immigration as an instrument for house prices may still suffer from *omitted variable bias*: It is conceivable that in areas or periods with generally high economic growth we observe higher immigration (through increased demand for labour) and at the same time higher house price and mortgage growth (through higher income and wealth growth). Relatedly, areas with currently low house prices might simultaneously be more attractive to immigrants and have more potential for subsequent house price growth. The vast majority of such omitted variable bias is likely to be soaked up by our set of control variables, as we can control First for region fixed effects (at different levels of granularity as discussed in the robustness section), Second for both monthly effects, Third for each applicant's income, wealth, pension wealth and liquid wealth, and fourthly for each real estate property's characteristics. However, as yet another safety layer against

[21] As Accetturo et al. (2014) show, immigration can affect house prices not only through immigrants' extra housing demand, but also since a higher density of immigrants may affect the attractiveness of housing in an area for natives. For our purposes we may remain agnostic about the channels through which immigration affects house prices.

possible reverse causality problems, we focus only on *OPI* rather than total immigration.

4.2 Origin-push immigration (OPI)

Potential remaining endogeneity of immigration to local economic conditions is an issue that has been extensively addressed by the literature on the effects of immigration on respectively employment and house prices. Papers in that literature have typically had available only aggregate data by region and period and have thus had reasons to be much more concerned about the issue than we do. In response, Card (2001) developed the *Shift Share* or *Origin Push* methodology to identify the causal effect of immigration on local employment. For this purpose, it has also been applied to the Swiss context by Basten and Siegenthaler (2013). More importantly for the present paper, Saiz (2007), Fischer (2012), Gonzalez and Ortega (2013) and Accetturo et al. (2014) have adapted the strategy for investigating the effect of immigration on house prices in respectively the US, Switzerland, Spain and Italy.[22] However, to the best of our knowledge this paper is the first to exploit such a strategy not for focusing on the causal effect of immigration itself, but in turn as an instrument for house prices in investigating their effect on the mortgage market.

Intuitively, the idea of the *Shift Share* strategy is to exploit only *that* part of the variation in immigration which can be explained by "push" factors in immigrants' countries of origin, as opposed to potential "pull factors" operating in the areas of destination – hence the name "Origin Push Immigration" (OPI). Therefore it focuses on the year-on-year *shifts* both in the total number of immigrants coming into any area of Switzerland and in their composition in terms of countries of origin. To obtain different treatment intensities for the 106 different MS areas, the total number of immigrants is then distributed to the 106 areas not according to their actual present-year flows (which may be partly endogenous) but, for each country of origin, according to the *shares* with which they were distributed in a historical year in the past. This exploits the finding that, on top of taking into account local economic opportunities (variation which we thus do not exploit), immigrants do also have a tendency to move to areas where their compatriots in earlier waves of immigration have already settled, as found by Bartel (1989).

The instrument does thus respond to both cross-sectional and inter-temporal variation. In our baseline specification purely inter-temporal variation is soaked up by monthly fixed effects. However, omitting these does not materially change our results, as long as we add a control for refinancing costs (Libor rates plus interest swap rates on the request day) to the mortgage rate regressions.[23]

[22] Badarinza and Ramadorai (2015) use the same idea to investigate the effect of political turmoil abroad on London house prices via capital flows (not necessarily with migration of the owners): They exploit the fact that foreigners buying property in London are ceteris paribus more likely to buy in an area if that area contains already many residents from their country of origin.

[23] See our Appendix for details.

4.3 A numerical example on how to compute OPI

To illustrate the functioning of the instrument, Table 5 gives an example involving the two characteristic immigrant groups from respectively Germany and ex-Yugoslavia[24], the MS areas Zurich and Geneva, and the years 1995 (our earliest baseline year) and 2008 (the earliest year of our *Comparis* sample). Panel (A) shows the necessary raw data, Panel (B) the resulting values for the endogenous regressor actual immigration and the instrument *OPI*, both in capita terms. Panel (C) shows the resulting values scaled by an area's previous year's population levels. We show this in Column (1) for immigrants from Germany, in Column (2) for those from Ex-Yugoslavia, and in Column (3) we show the corresponding raw data values for all origins combined.

Numerical example to illustrate the functioning of the instrument — Table 5

		From Germany (1)	From Ex Yugoslavia (2)	From Anywhere (3)
(A)	Imm. into Switzerland 1995	8,215	20,169	83,456
	Share in Zurich 1995	14.22%	6.28%	7.90%
	Share in Geneva 1995	5.79%	2.62%	14.34%
	Imm. into Switzerland 2008	34,270	7,739	125,937
	Share in Zurich 2008	13.12%	5.34%	8.56%
	Share in Geneva 2008	2.23%	8.61%	14.18%
(B)	Actual Immigrants ZH 2008	4,496	413	
	Origin-Push Imm. ZH 2008	4,873	486	
	Actual Immigrants GE 2008	764	666	
	Origin-Push Imm. GE 2008	1,984	203	
(C)	Actual Imm. /Pop. ZH 2008	1.25%	0.12%	
	Origin-Push Imm. / Pop. ZH 2008	1.36%	0.14%	
	Actual Imm. / Pop. GE 2008	0.17%	0.15%	
	Origin-Push Imm. / Pop. GE 2008	0.45%	0.05%	

This table shows in Panel (A) the raw data, in Panel (B) actual and instrument values for 2008 for respectively MS areas Zurich and Geneva. The instrument values, denoted as Origin-Push or Shift-Share Immigration are computed according to Equations (1) and (2) of Section 4.5. Panel (C) shows the corresponding values as percentage of previous year's (2007) population levels, which were respectively 358'540 for the MS area Zurich and 438'177 for the MS area Geneva.

Sources: Illustrative Example

Looking at Panel (A), we see that in 1995 Switzerland experienced gross immigration of 8,215 from Germany and of 20,169 from ex-Yugoslavia, where the latter was largely driven by the Yugoslav Wars acting as push-factor. Total gross immigration into Switzerland in 1995 amounted to 83,456 individuals. By 2008 the legacy of the Yugoslav Wars had largely receded and so Switzerland saw far fewer immigrants from ex-Yugoslavian countries. By contrast, labor market slack at home now motivated many Germans to move to Switzerland. Furthermore, immigration of Germans (and, for that matter, any EU citizen) had been facilitated relative to 1995 by

[24] Since the country definitions have changed over the years and immigrant numbers for many individual countries are small, we have included all countries on the territory of former Yugoslavia in a single origin group.

the Free Movement of Persons (FMP) Treaty concluded between Switzerland and the EU and implemented in 2002, as discussed in Basten and Siegenthaler (2013). So between 1995 and 2008, the numbers of immigrants from these two origins changed in opposite directions, with now only 7,739 gross immigrants coming from Ex-Yugoslavia but 34,270 from Germany. At that time, total gross immigration into Switzerland amounted to 125,937 individuals. This example shows that not only did total immigration into Switzerland fluctuate widely over the years, but so did the composition of immigrants' countries of origin. The FMP Treaty is one of the major factors contributing to that change in origin nationalities. Given the different destination area preferences of different origin nationalities, this shift translated also into a change in destinations exogenous to our MS area comparisons. The FMP Treaty thus additionally strengthens our setup relative to a *Shift Share* setup without such structural breaks.

The destinations of a given nationality of immigrants did also change over the years: While in 1995 close to 6% of German immigrants into Switzerland opted for Geneva, in 2008 only slightly more than 2% did. By contrast, only 2.62% of immigrants from Ex-Yugoslavia went to Geneva in 1995, but 8.61% did in 2008. These changes in destinations could at least partly be due to a destination area's economic prospects: While immigrants from Ex-Yugoslavia in 1995 were mostly war refugees distributed across Switzerland by the Swiss government, in 2008 they were more likely to choose their destination according to where they expected the best economic prospects for them. In order to avoid this possible source of endogeneity, the shift-share instrument distributes them as if 1995 shares were still applicable, thus exploiting the fact that to the extent to which immigrants do *not* go by economic prospects, they may go to where they happen to already know someone, are more likely to find shops and associations corresponding to their preferences, etc.

Looking at Panel (B), our instrument thus says that in 2008, based on 2008 totals but 1995 shares, 0.1422*34,270 = 4,873 Germans and 0.0628*7,739=486 immigrants from Ex-Yugoslavia move to Zurich. Likewise, the instrument tells us that respectively 1,984 Germans and 203 immigrants from Ex-Yugoslavia move to Geneva in 2008. Actual immigrant numbers for Zurich (Geneva) in 2008 were respectively 4,496 (764) Germans and 413 (666) from Ex-Yugoslavia. As the table shows, the *OPI* we use as instrument is sometimes higher, sometimes lower than the actual number of immigrants for that MS area and year. This can also be seen when we look at the scaled values in Panel (C). Given these predictions for each year, MS area and nationality, we then sum up within each year and MS area but across nationalities, so as to obtain a single instrument value for each year and area. While for our baseline we compute instrument values using the shares from 1995, the earliest year available, our robustness checks use 2008 as first sample year and 2000 as an intermediate year.

4.4 Formal computation of OPI and estimating equations

More formally, OPI from origin country *o* into destination area *d* in year *t* is computed as follows:

$$z_{o,d,t} = (z_{o,Switzerland,t}) * (\alpha_{o,d,1995}) \quad (1)$$

where $z_{o,Switzerland,t}$ is the total inflow of origin *o* immigrants into Switzerland in year t and α is the share of origin *o* immigrants from 1995 who went to destination area *d* in 1995.

We compute this for each origin *o*, then sum up over all countries of origin:

$$Z_{d,t} = \sum_o z_{o,d,t} \quad (2)$$

Overall, given our instrument and control variables explained above, we first estimate the following first stage equation:

$$lnHousePrice_{i,d,t} = \alpha + \beta Z_{d,t} + \gamma_c + \delta_t + \theta controls_i + \varepsilon_{i,d,t} \quad (3)$$

for mortgage requests *i* submitted in MS area *d* (nested within cantons/states) in year *t*. Beyond the instrument $Z_{d,t}$ explained above, this includes time (monthly) fixed effects δ_t, canton (or, in a variant labor market region) fixed effects γ_c, as well as a long list of control variables capturing the characteristics of the object to be financed and the household applying for a mortgage, $controls_i$. Given the instrumented values of the log house price obtained through these first stage estimations, we then estimate a set of second stage equations of the following form:

$$Outcome_{i,d,t} = \vartheta + \mu \widehat{lnHousePrice}_{i,d,t} + \rho_c + \tau_t + \varphi controls_i + \omega_{i,d,t} \quad (4)$$

We use four different outcome variables: As a measure of mortgage demand we use the log of the requested mortgage amount, and as measures of mortgage supply we use respectively the number of offers a request attracts[25], the best interest rate offered in response to a request, and the median interest rate offered in response to that request. In our setup lenders cannot choose to supply only a smaller mortgage amount than requested, so outright rejection or an offer at an unattractive price are the two ways for a lender to signal he is less keen to make a loan. And it seems plausible that ceteris paribus an applicant who receives fewer and more expensive offers is less likely to go ahead and conclude the contract than one receiving more attractive offers.

4.5 Focus on within state variation and request level controls

An important requirement for the validity of any instrumental variable strategy is the exclusion restriction, whereby the instrument may affect the outcome only through the instrumented variable. In our case this means that exogenous immigration may affect mortgage demand and supply only through house prices – *conditional on our set of control variables*. In our setup a careful specification and discussion are important, because the previous work cited above has shown that in Switzerland immigration has also had a positive effect on employment. Does that mean that with better employment prospects and/or higher incomes mortgage applicants may also request and/or be supplied with higher mortgage amounts?

Here two important advantages of our dataset relative to most previous papers with an origin-push methodology come into play. The first is that we are able to explicitly control for incomes, savings, and all other household financial variables. This enables us to close down households' own incomes and savings as a potential alternative channel for the reduced form effect of immigration on mortgage demand and mortgage supply. This is a major advantage over previous papers with a comparable instrumental variables approach but restricted to aggregate data.

At least as important is our second advantage: We are able to include in our specification not only year by month fixed effects, but also fixed effects for the 26

[25] For that outcome measure it is also important to have the canton fixed effects, since the number of banks potentially making offers does differ across cantons (some cantonal banks offer only in specific cantons), but not within a canton.

Swiss cantons (states). As a result, we are able to focus on variation in immigrant flows and resulting house prices between different neighborhoods (MS areas), but always *within a given canton*. This is advantageous because the limited size of most cantons as well as Switzerland's excellent public transport make it possible to commute to a job from any MS area in the canton. By contrast, there are important political differences between Swiss cantons, not least in marginal tax rates, see e.g. Basten and Betz (2013) or Basten et al (2014b). So what if immigration did exert some influence on applicants' labor market prospects that is not yet controlled for by applicants' own incomes and household finances? Then this will be captured by the canton fixed effects, because each canton forms a common labor market or part thereof. In fact, the Swiss Federal Office of Statistics has defined 16 labor market regions such that mobility within each area is high and between different areas low. These are more coarse than the 26 cantons, so in our baseline regressions we use indicators for the 26 cantons to capture differences in both labor market and general policy environment. In a variation in the Appendix we use only indicators for the 16 official labor market regions as defined by the Swiss Federal Office of Statistics.

Put differently, our specification exploits the fact that labor market prospects may motivate immigrants to move to a different canton or labor market region, whereas economic factors like rents (not exploited) and the residence patterns of compatriots (exploited) determine where within a canton or labor market area to reside. In the robustness section we discuss the consequences of this within-canton focus further and introduce also some variants, including one in which we replace our fixed effects for the 26 cantons with fixed effects for 16 labor market regions defined by the Statistics Office.

The same set of fixed effects also addresses the possible concern that immigrants from a given source country may have a tendency to enter particular labour market sectors (e.g. Germans may be likely to enter engineering sectors) and hence be more likely to move to cantons that have a lot of jobs in that sector. Because we focus on variation between different neighbourhoods within the same canton or official labour market region, differences in the sectoral compositions of different cantons or labour markets do not influence our estimates. In addition, note that the sectoral composition of each nationality group is by no means stable. Thus Credit Suisse Global Research (2013) shows that while in 2009 the group of immigrants from Portugal, Spain and Italy working in catering and repair services was more than 50% larger than that working in financial services, only 3 years later the largest group was working in financial services.[26]

4.7 Immigrants as house buyers?

A final possible violation of the exclusion restriction may arise if immigrants themselves show up as mortgage applicants. In general this seems of limited concern since we know from the studies cited above that in Switzerland immigrants rarely buy real estate themselves, or at least not right in their year of arrival in which they induce variation in our instrument: Since many immigrants are not sure initially how long they will stay for, whether and when their family follows them, and how the new market works, they will typically first rent. This influx into the market for rental housing

[26] They also show large year-on-year changes in the national composition of immigration: Their Graph 5 shows that net immigration from Germany was below 10,000 in 2002, above 30,000 in 2007 and 2008, and again below 10,000 by 2012.

may however bid up rents and thereby motivate more long-time residents to switch to owner-occupied housing. This mechanism is also supported by Figure 1, which shows that rents and purchase prices have very much co-moved over the years of our sample. As an additional factor to ensure that our results are not driven by increasing the numbers of immigrants applying for mortgages, it is helpful that we are able to observe and control for all the same household characteristics that lenders are able to observe. In particular, banks do not know whether a given applicant is himself an immigrant. They can therefore not price mortgages based on how they expect different immigrant groups to perform as borrowers. What banks do observe is applicants' income, total wealth, liquid wealth and pension wealth, all of which may have been influenced by characteristics correlated with the applicant's potential immigrant status and nationality. Exploiting the comprehensive information and multiple dimensions of our micro data, we are able to fully control for all of these characteristics.

To conclude, the general idea of our paper is to identify the causal effect of house prices on respectively mortgage demand and mortgage supply, by instrumenting house prices with immigration. More specifically, we use as instrument only *OPI*, so as to exclude possible endogeneity of immigration itself. To strengthen the reliability of our results further still, we focus only on within-state variation and include request level controls. The instrument's strength derives from the fact, that during the period under observation OPI played a major effect on Switzerland, as the relatively dire economic situation in the surrounding Eurozone led to historically high levels of immigration, as Basten and Siegenthaler (2013) explain in more detail.

5. Results

5.1 Main results

Table 6 presents our main results. Column (1) shows our estimates of the first-stage relationship between origin push immigration and house prices, which is common to all instrumental-variable results displayed in the following columns. Column (2) shows the second-stage relationship for the effect of house prices on mortgage demand, and Columns (3)-(5) show the effect of house prices on different measures of mortgage supply. All columns use the same comprehensive set of covariates, which we describe in more detail below.

As expected, the first-stage relationship is positive. It tells us that extra immigration worth 1% of the previous year's resident population is associated with a 9.3% increase in house prices. This is larger than the house price impact of 3.2%-3.4% (as opposed to merely 1% for rents) in Saiz (2007), but in line with the estimated 8-11% impact on rents in Saiz (2003), in particular if we assume that – as suggested by the Saiz (2007) results – the impact on prices (not analysed) in that setup may have been even larger than that on rents. Why do his estimates differ so much? Apart from methodological differences (Saiz 2003 uses difference-in-difference estimators rather than shift-share / OPI estimators), the key difference seems to lie in the extent of immigration: While Saiz (2007) analyses the impact of annual immigration of the magnitude of 0.3% of the resident population, Saiz (2003) analyses the impact of a one-off shock of immigrants worth 9% of the resident population. The magnitude of immigration in our setup is in between those two, amounting to on average 1.4% p.a.

(higher in hot spots like Zurich) but over many consecutive years. Furthermore, compared to most US cities, Switzerland is characterized by relatively strict building restrictions: Using non built-up land or even just adding extra floors is often forbidden. Therefore the addition of more housing does often require to tear down and replace existing buildings, which bids up building costs and may thus magnify the effect of population growth on house prices.

Main Instrumental Variable Results

Table 6

	First Stage	Mortgage Demand	Mortgage Supply		
	Ln House Price (1)	Ln Mortg. Amount (2)	Number of Offers (3)	Best Int. Rate (4)	Median Int. Rate (5)
Origin Push Immigration	0.093***				
	(0.007)				
Ln House Price (instrumented)		0.531***	–0.974**	0.154***	0.176***
		(0.071)	(0.412)	(0.053)	(0.045)
Ln Income	0.311***	0.247***	0.854***	–0.092***	–0.071***
	(0.026)	(0.034)	(0.164)	(0.020)	(0.017)
Ln Wealth	0.067***	–0.022***	0.214***	–0.028***	–0.028***
	(0.006)	(0.007)	(0.038)	(0.005)	(0.004)
Ln Liquidity	0.046***	0.020***	0.118***	–0.008**	–0.006*
	(0.003)	(0.005)	(0.027)	(0.004)	(0.003)
Other Fin. Obligations (y/n)	0.008	0.019**	–0.355***	0.015**	0.009
	(0.010)	(0.009)	(0.052)	(0.007)	(0.006)
Other Real Estate (y/n)	0.037***	–0.031***	–0.452***	0.013**	–0.008
	(0.009)	(0.008)	(0.049)	(0.007)	(0.006)
House Age (Decades)	–0.021***	–0.010***	–0.020**	0.005***	0.005***
	(0.001)	(0.002)	(0.010)	(0.001)	(0.001)
Constant	8.839***	3.061***	3.554	1.693***	1.228***
	(0.271)	(0.629)	(3.663)	(0.474)	(0.403)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	12,753	12,753	12,753	12,753	12,753
R-sq	0.524	0.614	0.300	0.865	0.895

This table shows in Column (1) the common 1st stage effect of origin push immigration on the house price. Column (2) shows the 2nd stage estimates of the causal effect of the house price on mortgage demand, measured by the amount requested. Columns (3)-(5) show the 2nd stage estimates of the effect on mortgage supply, as measured by respectively the number of offers a household receives, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

Important for the present purposes though is that our first-stage regressions reveal our instrument to be strong: The coefficient is statistically significant far above the 1% threshold. The F statistic for the hypothesis of a jointly zero effect of all instruments, in this case just *OPI*, on house prices amounts to 216.79. It does thus by

far exceed all relevant Stock and Yogo (2005) critical values and we can confidently reject the null of weak instruments.

Thanks to our large sample size and good data quality, we obtain similarly high statistical precision when estimating our second stage relationships. The estimates obtained there tell us that a 1% higher house price causes the household to request a 0.53% higher mortgage amount. This implies the expected positive effect, but the coefficient size below unity implies that LTV ratios are falling as house prices increase. This is in line with similar findings for the UK reported in FSA (2009), for Japan reported in Ono et al. (2014), and for Switzerland in SNB (2015). It may seem surprising at first sight, but makes sense from a risk-management perspective taking into account that the values behind LTV ratios (and certainly the actual house prices used in this study) increase in real time and may be considered over-valued relative to fundamentally justified values. This gives both banks and (in a legal setup with full recourse) households an incentive to increase their loans less than the house prices – if they can afford so. In Switzerland they can because of tax incentives: as Swiss households can deduct interest payments from their taxable income, they tend to choose higher leverage than necessary given house price and financial wealth at the baseline. For a comparative statics thought experiment in which house prices increase however, this means that when households or banks deem lower LTV ratios desirable for risk-management reasons, households still have leeway to increase their down payment.

We now turn to the results on mortgage supply. Interestingly these higher house prices are not found to *increase* banks' willingness to lend, so the "collateral channel" described inter alia in IMF (2011) does not seem to operate here. If anything, Column (3) shows that conditional on our set of real estate property, household, location and time controls, each 1% increase of the house price does *reduce* the number of offers by 0.009. Furthermore, conditional on making an offer, the lenders in our sample charge if anything *higher* risk premiums for a higher house price: Thus Columns (3)-(5) show that each percent increase in the house price raises the best interest rate offered by 0.00154 percentage points (or 0.154 basis points), and raises the median interest rate offered by 0.00176 percentage points (0.176 basis points). To gauge the economic significance of these effects, consider that between 1998 (2008) and 2013 house prices have increased by about 75% (27%) at the national level, up to 90% (36%) in the region around Zurich, and up to 143% (29%) in the region around Geneva.[27] So the Swiss average increase over the full period would be predicted to lead to 0.675 fewer offers (i.e. about 10% fewer offers) and an increase of about 11.25 basis points in the best interest rate offered. These effects do not seem economically very big to us. So our main conclusion on the supply side is that, in contrast to demand, *supply has not expanded in response to higher house prices*, but also *decreases have at best been small*.

Our supply results are confirmed when, instead of using only one observation for each of our 12,753 requests we retain all 88,276 lender responses. We can then investigate the effect of house prices on the probability of each response being an offer, rather than of the effect on the number of offers per request. Table 7 of our Appendix displays estimates of the effect of house prices on respectively the probability of a response being an offer as well as, for the subsample of offers, on the offered interest rate. Estimations are repeated both with our regular set of covariates

[27] See SNB (2013a), Table O43a.

as well as with that augmented by lender fixed effects. In both cases we find that higher houses lead if anything to a lower offer probability (not significant at the conventional levels) as well as to higher interest rates (significant at the 1% significance level).

Next we turn to a brief overview of the effects of our control variables on house prices, mortgage supply and mortgage demand. Indeed, risk-adjusted pricing is reflected in the coefficients estimated on the control variables: While a higher income is ceteris paribus associated with a higher house price and a higher mortgage amount, lenders respond to higher incomes with on average more offers and more attractive interest rates. The same positive supply responses can be observed for wealth and, for the number of offers, also for liquidity. By contrast, having other financial obligations (which increases the requested mortgage amount) or other real estate (which decreases it) both reduce the number of offers. So does, ceteris paribus, the age of the house: Requests with older houses receive, conditional on the house price and location, fewer offers and are charged higher interest rates. These relationships observed for our set of control variables confirm that banks do make use of this information, rather than just submitting uniform offers. As the coefficient estimates on the control variables feature reasonable signs and sizes, these results also support our regression specifications.

5.2 Evidence on the reverse causality from mortgage lending to house prices

It is also interesting to compare the instrumental variable estimates to the results we would have obtained with Ordinary Least Squares estimations, i.e. without isolating the *causal* effect of house prices. Table 7 displays these OLS results and shows that the mortgage demand estimates biased by reverse causality are about 50% larger. With respect to mortgage supply, they are biased toward less careful mortgage lending, with a smaller negative effect on the number of offers and a negative rather than positive effect of the house price on interest rates. Both findings suggest that the reversely causal effect of mortgage volumes on house prices is indeed strongly positive. Overall then, we have evidence of a two-way causality between house prices and mortgage volumes in Switzerland.

Ordinary Least Square (OLS) Results

Table 7

	Mortgage Demand	Mortgage Supply		
	Ln Mortg. Amount (1)	Number of Offers (2)	Best Int. Rate (3)	Median Int. Rate (4)
Ln House Price	0.777***	–0.351***	–0.010	–0.016**
	(0.013)	(0.063)	(0.007)	(0.006)
Ln Income	0.168***	0.655***	–0.040***	–0.010*
	(0.018)	(0.083)	(0.007)	(0.005)
Ln Wealth	–0.039***	0.171***	–0.016***	–0.015***
	(0.005)	(0.026)	(0.003)	(0.003)
Ln Liquidity	0.008**	0.089***	–0.000	0.003
	(0.003)	(0.019)	(0.003)	(0.002)
Other Fin. Obligations (y/n)	0.017**	–0.361***	0.016**	0.010*
	(0.008)	(0.051)	(0.006)	(0.005)
Other Real Estate (y/n)	–0.041***	–0.477***	0.020***	–0.000
	(0.007)	(0.046)	(0.006)	(0.005)
House Age (Decades)	–0.005***	–0.008	0.002***	0.001
	(0.001)	(0.006)	(0.001)	(0.001)
Constant	1.027***	0.451	2.794***	2.714***
	(0.141)	(0.790)	(0.094)	(0.079)
Year*Month FEs	Yes	Yes	Yes	Yes
Canton Fes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes
N	12753	12753	12753	12753
R2	0.639	0.307	0.871	0.903

This table shows in Column (1) the Ordinary Least Squares estimates of the association between house prices and mortgage demand, measured by the amount requested. Columns (2)-(4) show the associations between house prices and mortgage supply, as measured by respectively the number of offers a household receives, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

5.3 Changes over time

To gain a deeper understanding of the effects of house prices on mortgage demand and supply, we now look at how both have changed as the joint real estate and mortgage volume boom has progressed. To do so, we have interacted our main explanatory variable of interest, the log house price, with an indicator for the 2nd sub-period of our sample, 2011-13. For this reason, we now have to deal with two endogenous regressors: the house price in the first sub-period of our sample and the house price in the second sub-period (i.e. the house price times the period 2 indicator), and they are instrumented by respectively *OPI* in the first sub-period and *OPI* in the second sub-period (i.e. *OPI* multiplied by the period 2 indicator). This procedure of interacting both the excluded instrument and the endogenous

regressor with an exogenous sample split indicator to test for subsample differences is one we shall use several times below. For a more detailed explanation, see for instance Ozer-Balli and Sorensen (2010).

Years 2008-10 vs. years 2011–13

Table 8

	First Stage		Mortgage Demand	Mortgage Supply		
	Ln House Price (1)	Ln HP* I(yr>=2011) (2)	Ln Mortg. Amount (3)	Number of Offers (4)	Best Int. Rate (5)	Median Int. Rate (6)
Origin Push Immigration (OPI)	0.083***	–0.019***				
	(0.007)	(0.004)				
OPI*Indicator(year>=2011)	0.023***	0.134***				
	(0.009)	(0.008)				
Ln House Price			0.472***	–0.562	0.162***	0.196***
			(0.081)	(0.461)	(0.062)	(0.052)
Ln HP*Indicator(year>=2011)			0.153**	–1.065***	–0.022	–0.051
			(0.068)	(0.348)	(0.053)	(0.045)
I(yr>=2011)	0.067	13.515***	–2.132**	12.101**	–0.025	0.285
	(0.046)	(0.038)	(0.936)	(4.758)	(0.723)	(0.617)
Ln Income	0.311***	0.122***	0.247***	0.855***	–0.092***	–0.071***
	(0.026)	(0.012)	(0.034)	(0.165)	(0.020)	(0.017)
Ln Wealth	0.067***	0.029***	–0.022***	0.218***	–0.028***	–0.028***
	(0.006)	(0.004)	(0.007)	(0.039)	(0.005)	(0.004)
Ln Liquidity	0.046***	0.021***	0.019***	0.122***	–0.008**	–0.006*
	(0.003)	(0.002)	(0.005)	(0.027)	(0.004)	(0.003)
Other Fin. Obligations (y/n)	0.008	0.013*	0.018*	–0.344***	0.015**	0.009*
	(0.010)	(0.007)	(0.009)	(0.053)	(0.007)	(0.006)
Other Real Estate (y/n)	0.037***	0.003	–0.030***	–0.463***	0.013**	–0.008
	(0.009)	(0.007)	(0.008)	(0.050)	(0.007)	(0.006)
House Age (Decades)	–0.021***	–0.007***	–0.010***	–0.019*	0.005***	0.005***
	(0.001)	(0.001)	(0.002)	(0.010)	(0.001)	(0.001)
Constant	8.752***	–1.945***	3.926***	0.253	1.901***	1.368***
	(0.267)	(0.130)	(0.784)	(4.423)	(0.614)	(0.508)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	12753	12753	12753	12753	12753	12753
R-sq	0.524	0.998	0.609	0.292	0.865	0.894

This table tests whether the effects of interest differ between the 1st and the 2nd sub-period of our sample. It shows in Columns (1) and (2) the 1st stage regressions for respectively the house price in 2008-10 and that in 2011-13. Column (3) shows the 2nd stage estimate of the effect of the house price on mortgage demand, measured by the amount requested. The effect for 2008-10 is given by the coefficient in Line 3 alone, that for 2011-13 by adding to that the coefficient from Line 4 (Log HP*Indicator). Hence that coefficient tells us how the effect in 2011-13 differed from that before. By analogy, Columns (4)-(6) show the effects of the two house price variables on mortgage supply, measured by respectively the number of offers received, the best and the median interest rate offered. Robust SEs in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

Table 8 provides the results on the sample split by period. Columns (1) and (2) show both first-stage regressions, which again feed into all second-stage estimations in the following columns. Column (3) shows the effect of the house price on mortgage

demand and Columns (4)-(6) show that on mortgage supply. The interaction term in Line 4 shows how the marginal effect of house prices on these different outcomes in the second period differs from that in the first. Findings on this issue are twofold. First we find that the marginal effect of the house price on mortgage *demand* is stronger in the second than in the first period. This might reflect the fact that in the course of the boom houses have already become more expensive, while wealth has not increased as much, so households must rely more heavily on external finance. It may also reflect the fact that potentially the fraction of "marginal households", whose savings are low in relation to the envisaged house price, may have increased. Lenders respond to these changes in house prices by making *fewer* offers, which may reflect increased concerns about potential market overheating, but the inter-period difference in pricing behaviour is not statistically significant.

5.4 The effect of house prices for low- vs. high-LTV and PTI requests

Another way to deepen our understanding of how mortgage demand and supply respond to higher house prices is to analyse this separately for low and high LTV ratios, and for low and high PTI ratios. In contrast to the sample split by period, the indicator for high vs. low LTV is *endogenous to mortgage demand*: The higher the mortgage amount requested, the more likely the request is to be in the high-LTV and high-PTI subsamples. But the interaction procedure explained in the previous subsection is only valid if the interaction variable is exogenous, for otherwise interacting it with the instrument does not yield a valid second instrument. Therefore we cannot validly test for subsample differences in the effect of house prices on mortgage *demand* here.

By contrast, we may still validly test for differences in the effect on mortgage supply. This is based on the reasoning that in our setup LTV and PTI are not reversely caused by *request-specific* mortgage supply (*average* mortgage supply is being controlled for by our year by month as well as canton fixed effects), because offers are made only *after* requests have been submitted. Our robustness checks based on a Simultaneous Equations Model (SEM) below confirm that this reasoning is indeed appropriate

Table 9 and Table 10 display the results of the interactions with respectively LTV and PTI indicators. Like in the table on the first vs. the second sub-period of the sample, we interact both our endogenous regressor and our instrument with an indicator, now for respectively LTV ratios above 67% and for PTI ratios above 33%. These are commonly deemed relevant thresholds in the Swiss market and are also mentioned as such to applicants on the *Comparis* website. Traditionally, Swiss banks have required households to amortize the portion with an LTV above 67% and since 2012 they are required by regulation to do so.[28] For banks there are also changes in regulatory risk weights at the 67% threshold as well as at the 80% threshold. Given the second discontinuity at the 80% LTV as well as some outliers above that level, we focus in Table 9 on observations with LTVs below 80%. Table 9 shows that in the case of more leveraged households banks restrict the number of offers in response to high house prices more strongly than otherwise: The more "skin the bank is to put into the game", the more it wants to be compensated for additional risk. Point estimates also suggest that the interest rate response to house prices is higher for high-LTV than for

[28] This policy change is fully controlled for by our year by month fixed effects.

High- vs. low-LTV application

Table 9

	First Stage		Mortgage Supply		
	Ln House Price (1)	Ln HP* I(LTV>=67) (2)	Number of Offers (3)	Best Int. Rate (4)	Median Int. Rate (5)
Origin Push Immigration (OPI)	0.102***	–0.011**			
	(0.009)	(0.005)			
OPI*I(LTV>=67)	–0.016*	0.107***			
	(0.009)	(0.008)			
Ln House Price			–1.222***	0.169***	0.202***
			(0.433)	(0.060)	(0.051)
Ln HP*I(LTV>=67)			–0.957**	0.117*	0.057
			(0.415)	(0.063)	(0.055)
I (LTV>=67)	0.307***	0.146***	1.244***	–0.124***	–0.093***
	(0.031)	(0.015)	(0.210)	(0.024)	(0.020)
Ln Income	0.050***	0.015***	0.146***	–0.020***	–0.021***
	(0.007)	(0.005)	(0.038)	(0.005)	(0.004)
Ln Wealth	0.042***	0.026***	0.118***	–0.012***	–0.009**
	(0.004)	(0.003)	(0.029)	(0.004)	(0.004)
Ln Liquidity	0.023**	–0.005	–0.285***	0.012	0.003
	(0.011)	(0.008)	(0.061)	(0.008)	(0.007)
Other Fin. Obligations (y/n)	0.038***	0.018**	–0.502***	0.013*	–0.005
	(0.010)	(0.007)	(0.053)	(0.007)	(0.006)
Other Real Estate (y/n)	–0.020***	–0.010***	–0.029***	0.006***	0.005***
	(0.001)	(0.001)	(0.011)	(0.001)	(0.001)
House Age (Decades)	–0.086***	13.436***	12.432**	–1.528*	–0.714
	(0.014)	(0.012)	(5.639)	(0.863)	(0.751)
Constant	9.173***	–2.054***	3.580	1.756***	1.036**
	(0.309)	(0.155)	(4.282)	(0.602)	(0.518)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	9994	9994	9994	9994	9994
R-sq	0.523	0.998	0.338	0.867	0.895

This table tests whether the effect of house prices differs between high and low LTV requests. It shows in Col. 1 and 2 the 1st stage regressions for respectively the house price in applications with LTV<67% and in applications with LTV>=67%. Observations with LTV>80% are dropped. C. 3-5 show the effect of the house price on respectively the number of offers received, the best interest rate, and the median interest rate. In each case the effect for LTV<67% applications is given by the Line 3 coefficient alone, that for LTV>=67% applications by the sum of the coefficients from Lines 3 and 4. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: : Comparis and Swiss Federal Office of Statistics

low-LTV applications, however that difference is not statistically significant at conventional levels. Table 10 by contrast reveals no difference in the supply response of banks to house prices between more and less affordable requests. A possible

explanation for these differences between Tables 7 and 8 is that while highly leveraged households are particularly exposed to price risk, households with high PTI ratios are instead more exposed to interest rate and income risk, as explained in Brown and Guin (2013).

High- vs. low-PTI applications

Table 10

	First Stage		Mortgage Supply		
	(1) Ln House Price	(2) Ln HP* I(PTI>=33)	(3) Number of Offers	(4) Best Int. Rate	(5) Median Int. Rate
Origin Push Immigration (OPI)	0.069***	–1.441***			
	(0.015)	(0.527)			
OPI*I(PTI>=33)	0.001	0.137***			
	(0.000)	(0.022)			
Ln House Price			–1.188*	0.132	0.231***
			(0.700)	(0.102)	(0.088)
Ln HP*I(PTI>=33)			0.002	0.003	–0.000
			(0.018)	(0.003)	(0.003)
Indicator (PTI>=33)	0.455***	13.513***	0.806***	–0.139***	–0.116***
	(0.042)	(1.098)	(0.263)	(0.036)	(0.031)
Ln Income	0.066***	1.635***	0.150***	–0.025***	–0.027***
	(0.007)	(0.200)	(0.043)	(0.006)	(0.005)
Ln Wealth	0.028***	0.609***	0.114***	–0.009**	–0.006**
	(0.003)	(0.105)	(0.025)	(0.004)	(0.003)
Ln Liquidity	–0.034***	–1.014***	–0.227***	0.020**	0.014**
	(0.012)	(0.365)	(0.062)	(0.008)	(0.007)
Other Fin. Obligations (y/n)	0.063***	3.408***	–0.510***	0.002	–0.012
	(0.008)	(0.239)	(0.067)	(0.010)	(0.009)
Other Real Estate (y/n)	–0.011***	–0.217***	–0.026***	0.005***	0.003***
	(0.001)	(0.039)	(0.008)	(0.001)	(0.001)
House Age (Decades)	0.021***	14.226***	–0.059	–0.045	–0.003
	(0.001)	(0.037)	(0.255)	(0.041)	(0.036)
Constant	6.729***	–199.742***	8.702	2.595**	1.111
	(0.437)	(11.451)	(7.743)	(1.195)	(1.045)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	9994	9994	9994	9994	9994
R-sq	0.669	0.996	0.351	0.869	0.896

This table tests whether the effect of house prices differs between high and low PTI ratio requests. It shows in Col. 1 and 2 the 1st stage regressions for respectively the house price in applications with PTI<33% and in those with PTI>=33%. C. 3-5 show the effect of the house price on respectively the number of offers received, the best and the median interest rate. In each case the effect for PTI<33% is given by the Line 3 coefficient alone, that for PTI>=33% cases by the sum of the coefficients from ll. 3 and 4. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

5.5 Multi-family homes as proxy for income-producing real estate

Table 11 interacts our main regressors of interest with an indicator for multi-family homes (MFH), which can be seen as a proxy for Income-Producing Real Estate (IPRE). Given the evidence from other studies that migrants themselves tend to rent rather than buy, we would expect a larger first-stage effect of OP immigration on house prices for MFHs. This is confirmed by Columns (1) and (2), which show a first-stage effect of about 9% for non-MFHs but one of about 17% for MFHs. Column (3) shows tentative evidence that for MFHs house prices have a larger effect on the amount demanded, although that difference is not statistically significant. Columns (4) – (6) show that ceteris paribus high house prices make banks less nervous when the object

Multi-Family Homes vs. other (typically owner-occupied) objects — Table 11

	First Stage	Mortgage Demand	Mortgage Supply		
	Ln House Price (1)	Ln Mortg. Amount (2)	Number of Offers (3)	Best Int. Rate (4)	Median Int. Rate (5)
Origin Push Immigration	0.112***				
	(0.033)				
Ln House Price (instrumented)		0.662**	1.423	0.045	0.138
		(0.264)	(1.184)	(0.180)	(0.168)
Ln Income	0.151***	0.097**	–0.098	–0.027	–0.035
	(0.036)	(0.048)	(0.192)	(0.030)	(0.028)
Ln Wealth	0.051**	–0.009	0.002	0.004	–0.003
	(0.022)	(0.023)	(0.097)	(0.017)	(0.016)
Ln Liquidity	0.079***	0.025	–0.046	–0.021	–0.022
	(0.019)	(0.025)	(0.114)	(0.019)	(0.017)
Other Fin. Obligations (y/n)	0.007	0.019	–0.011	–0.036	–0.046**
	(0.040)	(0.034)	(0.152)	(0.025)	(0.023)
Other Real Estate (y/n)	0.371***	0.060	–0.940**	–0.038	–0.100
	(0.040)	(0.106)	(0.479)	(0.076)	(0.071)
House Age (Decades)	–0.030***	–0.013	0.093**	–0.003	0.001
	(0.004)	(0.008)	(0.038)	(0.006)	(0.006)
Constant	10.588***	2.875	–12.655	3.791*	2.886
	(0.398)	(2.817)	(12.751)	(1.939)	(1.807)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	977	977	977	977	977
R-sq	0.418	0.629	0.120	0.800	0.830

This table investigates whether results differ when we focus on Multi-Family Homes (MFH), typically bought for renting out rather than for owner-occupancy. It shows in Col. 1 the common 1st stage effect of origin push immigration on the house price. Column (2) shows the 2nd stage estimates of the causal effect of the house priceon mortgage demand, measured by the amount requested. Columns 3-5 show the 2nd stage estimates of the effect on mortgage supply, as measured by respectively the number of offers received, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Sources: Comparis and Swiss Federal Office of Statistics

is a MFH. Presumably this is so since for MFHs house prices must be assessed in relation to expected rents, which are not being observed and controlled for here.

5.6 New mortgage vs. refinancing requests

Table 12 continues with a distinction between new mortgage and refinancing requests, each of which makes up about half of our sample. This is because when they first buy a house, Swiss households will typically get a fixed rate or Libor-pegged mortgage for a fixed period of mostly up to 10 years. After that time they will not have repaid their mortgage but must renegotiate a refinancing deal. In the period covered by our sample, mortgage interest rates were typically lower than 5 or 10 years before and so all such households had an incentive to renegotiate both with their previous bank and with other banks via the *Comparis* website. Another specificity of our sample is that at the time at which households were asking for a refinancing mortgage the market value of their house had typically increased a good deal above that at which they had concluded their initial mortgage contract. In contrast to many other countries however[29], only about 12% of refinancing requests in our sample asked for a higher than the original mortgage amount.[30] In that environment of increasing house prices, these 12% are also more likely (66%) to provide an updated house value instead of the original purchase price[31] than those asking for the same as the original amount (48%) or those who have already repaid part of the mortgage (42%).

In line with few households exploiting the rising house prices to *increase* their mortgage, Table 12 reveals that for refinancing requests house prices have a significantly smaller effect on mortgage demand than for new mortgages, as indicated by the negative coefficient on the interaction between the house price and the refinancing indicator in Column (3), Line 4. By contrast, the role of house prices for the degree of caution banks exert in their mortgage supply is if anything smaller for refinancing requests than for new mortgages. This can be seen from the fact that the interactions in Columns (5)-(7) carry the opposite sign of the main effects, with that for the number of offers also being statistically significant. The finding may firstly reflect that with few mortgage amount increases most refinancing requests now have a lower leverage relative to current house prices than the new mortgage requests. Second, refinancing requests have already been checked once by the bank financing the initial mortgage, so that potential refinancing banks may find fewer remaining shortcomings here than for new mortgage requests.

[29] E.g. Mian and Sufi (2011) show that in the US subprime boom leverage was increased by households taking equity out of their homes.

[30] At the same time, only about 12% had reduced the amount, with 76% asking for the same as the original amount, a consequence of tax incentives to save into other assets but retain mortgage debt as high as allowed by regulators and banks.

[31] The website allows for either, but asks households to specify the source of their house value.

New Mortgages vs. Refinancing requests

Table 12

	First Stages		Mortgage Demand	Mortgage Supply		
	Ln House Price (1)	Ln HP* I(Rollover) (2)	Ln Mortg. Amount (3)	Number of Offers (5)	Best Int. Rate (6)	Median Int. Rate (7)
Origin Push Immigration (OPI)	0.095***	–0.011**				
	(0.008)	(0.005)				
OPI*Indicator(Rollover)	–0.005	0.117***				
	(0.008)	(0.008)				
Ln House Price			0.649***	–1.483***	0.203***	0.175***
			(0.069)	(0.441)	(0.058)	(0.050)
Ln HP*Indicator(Rollover)			–0.160**	0.934***	–0.096*	0.014
			(0.067)	(0.349)	(0.052)	(0.045)
Indicator(Rollover)	0.002	13.438***	1.949**	–12.272***	1.285*	–0.218
	(0.013)	(0.011)	(0.903)	(4.752)	(0.704)	(0.611)
Ln Income	0.310***	0.119***	0.224***	0.911***	–0.097***	–0.073***
	(0.026)	(0.012)	(0.031)	(0.168)	(0.020)	(0.017)
Ln Wealth	0.067***	0.017***	–0.009	0.199***	–0.027***	–0.026***
	(0.006)	(0.004)	(0.007)	(0.039)	(0.005)	(0.004)
Ln Liquidity	0.045***	0.013***	–0.020***	0.197***	–0.013***	–0.010***
	(0.004)	(0.003)	(0.005)	(0.028)	(0.004)	(0.003)
Other Fin. Obligations (y/n)	0.008	0.021***	0.009	–0.347***	0.015**	0.007
	(0.010)	(0.008)	(0.008)	(0.053)	(0.007)	(0.006)
Other Real Estate (y/n)	0.037***	0.032***	–0.016**	–0.491***	0.016**	–0.007
	(0.009)	(0.007)	(0.008)	(0.050)	(0.007)	(0.006)
House Age (Decades)	–0.021***	–0.009***	–0.009***	–0.022**	0.006***	0.005***
	(0.001)	(0.001)	(0.002)	(0.010)	(0.001)	(0.001)
Constant	8.844***	–1.596***	2.121***	8.918**	1.141**	1.305***
	(0.274)	(0.135)	(0.652)	(4.179)	(0.559)	(0.478)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	12753	12753	12753	12753	12753	12753
R-sq	0.524	0.998	0.660	0.301	0.864	0.894

This table tests whether the effect of the house price differs between new mortgages and refinancing requests. It shows in Columns (1) and (2) the 1st stage regressions for respectively the house price for new mortgages and for the house price in refinancing applications. Column (3) shows the effect of both house price variables on mortgage demand, measured by the amount requested. C. (4)-(6) finally show the effects of the two house price variables on mortgage supply, measured by respectively the number of offers received, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

5.7 The effects for risk-seeking vs. risk-averse mortgage applicants

It is also interesting to compare the effects of house prices on mortgage demand and supply for differentially risk-averse applicants. To do so, Table 13 shows the results for different types of mortgage model: Risk-averse applicants can be deemed more likely to choose a model in which the interest rate is fixed. As our summary statistics revealed, this applies to 81% of requests. Less risk-averse applicants may choose models in which the rate is tied to LIBOR interest rates or can be adjusted freely by banks in response to changing market environments[32]. Another interesting subsample are households applying for special mortgages with rate discounts for energy-efficient buildings, discounts for children, or initial discounts ("step mortgages"). Since we compare more than two categories here, we are not presenting an interaction of the main effect with an indicator, as before. Instead we have estimated results separately for different subsamples. Panel (A) presents, for

Results by mortgage model

Table 13

			First Stage	Mortgage Demand	Mortgage Supply		
			Ln House Price (1)	Ln Mortg. Amount (2)	Number of Offers (3)	Best Int. Rate (4)	Median Int. Rate (5)
(A)	All	FS/IV	0.093***	0.531***	–0.974**	0.154***	0.176***
	(N=12'753)		(0.007)	(0.071)	(0.412)	(0.053)	(0.045)
		OLS		0.777***	–0.367***	–0.014	–0.019**
				(0.013)	(0.063)	(0.008)	(0.008)
(B)	Fixed Rate	FS/IV	0.088***	0.502***	–1.178**	0.143***	0.112***
	(N=10'381)		(0.007)	(0.083)	(0.483)	(0.054)	(0.040)
		OLS		0.755***	–0.401***	–0.017*	–0.021***
				(0.014)	(0.069)	(0.009)	(0.008)
(C)	LIBOR & Variable Rate	FS/IV	0.121***	0.681***	–0.082	0.123	0.403**
	(N=1'381)		(0.023)	(0.193)	(0.926)	(0.170)	(0.163)
		OLS		0.858***	–0.122	–0.009	0.361**
				(0.032)	(0.155)	(0.028)	(0.170)
(D)	Special	FS/IV	0.090***	0.573***	–2.266	0.097	0.310
	(N=991)		(0.021)	(0.193)	(1.573)	(0.213)	(0.219)
		OLS		0.823***	–1.031***	0.012	–0.018
				(0.027)	(0.260)	(0.040)	(0.034)

This table shows in Column (1) the first-stage effects of origin push immigration on house prices, in Column (2) the effects of house prices on mortgage demand, and in Columns (3)-(5) the effect of house prices on mortgage supply. It shows these in Panel (A) for our full sample, in Panel (B) only for mortgages whose rates are fixed for between 1 and 10 years. In Panel (C) it shows the effects only for Libor and variable rate mortgages, in Panel (D) for "Special" mortgages with discounts for energy-efficient buildings or large families, or initial discounts ("step mortgages"). Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Sources: Comparis and Swiss Federal Office of Statistics

[32] In contrast to LIBOR mortgages, these can typically be terminated without punishment by either side at any time. These 5% of contracts are typically chosen by households who bet that interest rates will fall further and who hope to switch to a fixed-rate model later.

reference, the results for our full sample. Panel (B) presents results only for fixed-rate mortgages, which with 10,381 of 12,753 requests presents the large majority of observations. Out of these 10,381 requests, again the largest groups (not displayed separately) are mortgages with rates fixed for either 5 or 10 years, whereas the groups with rates fixed for 1, 2, 3, 4, 6, 7, 8 or 9 years are smaller. The outcome variables presented in the 5 columns are the same as before. In the discussion of these results we focus on the IV results. A comparison of the effects of house prices on mortgage demand in Column (2) between on the one hand fixed rate mortgages (Panel B) and on the other hand adjustable rate mortgages (Panel C) shows that for adjustable rate mortgages house price increases result in larger mortgage amount increases, reflecting a higher leverage and starting PTI of this type of applicant. Column (5) also provides some evidence that for that riskier group house prices have a larger marginal effect on the median interest rate (although the general interest rate level, not displayed, is of course lower for those contracts), suggesting that banks do also perceive these clients as on average riskier and take this into account in their pricing. An above-average effect of on mortgage demand is also found for special rate mortgages.

5.8 Robustness

Our Appendix explores in detail the robustness of our results. Here we provide a brief summary of these robustness checks. The first section there augments our baseline instrumental variable model, in which we use an excluded instrument only for house prices, with a more general simultaneous equations model that has an "excluded instrument" also for mortgage demand. This allows us to control for direct effects of mortgage demand on mortgage supply. Doing so does not significantly change the estimated effects of house prices on respectively mortgage demand and mortgage supply.

We also explore the role of different sets of fixed effects. We find that time fixed effects do not matter much for the mortgage demand equations, but do matter for mortgage supply, because they control for changes over time in the general level of interest rates. Omitting canton fixed effects does, expectedly, lead to larger estimates. This likely reflects that these canton fixed effects do successfully absorb remaining cross-sectional differences in price levels. By contrast, whether we do this by means of canton or labour market fixed effects does not matter. Mortgage maturity model fixed effects leave our point estimates largely unchanged, but increase statistical precision in our interest rate regressions.

For the effects of higher house prices on mortgage supply, we also de-collapse our dataset and use observations on all lender responses rather than only one observation per request. This allows us to add to our already extensive set of controls lender fixed effects. These regressions yield very much the same effects as those based on one observation per request only, with if anything ceteris paribus fewer offers and higher interest rates for requests with higher house prices.

In further robustness checks, we show that results do not change in a significant way when we use different historical shares to construct our instrument or when exclude the 5 MS areas with the largest inflows of German immigrants. We also show that the effects are not driven by the cantons of Zurich and Geneva, but are in fact weaker there. In particular, banks respond less cautiously to high house prices in Zurich and Geneva than elsewhere, presumably because despite the higher levels they

consider prices more justified in these centres than in other regions. Finally, the Appendix shows that the statistical significance of our results does not hinge on how we cluster our standard errors.

6. Conclusion

This paper is one of the very few that use instrumental-variable methodology to disentangle the direction of causality between housing and mortgage markets. It is also, to the best of our knowledge, the first to do so for a setting other than the recent US subprime bubble. We address this two-way causality in a new way: By use of an origin-push (shift-share) strategy, we isolate the exogenous component of immigration into a geographical area. Thereby we exploit variation in house prices that has not been reversely caused by mortgage lending. To the best of our knowledge, we are the first to apply such a strategy to the analysis of mortgage markets. Furthermore, the use of micro instead of regional level data, as well as our focus on within-canton, within-year, within-month variation, renders this approach even more robust than it has been in many existing shift-share papers which had to work with aggregate data only. We find that a 1% higher house price causes a 0.52% higher requested mortgage amount. The total, non-causal partial correlation between house prices and mortgage volumes is a good deal larger. Causality therefore is not restricted to one direction, but does flow in both ways.

At the same time, we are able to trace out separate causal effects of house prices on respectively mortgage demand and mortgage supply. We find strong evidence that the higher house prices have specifically led to an expansion of mortgage *demand*. Interestingly, our results do not support the hypothesis that higher house prices and therefore more valuable collateral cause banks to lend more or at lower rates. To the contrary, we find that higher house prices attract ceteris paribus *fewer* mortgage offers and *higher* mortgage interest rates. This result emphasizes the importance of the demand channel even more. However, it has been obtained by comparing requests with differently expensive houses submitted in the same low-interest rate environment. So while we find lenders to be careful about high house prices *for given general interest rates* that does not rule out that in the market as a whole the low interest rates of recent years have also caused an expansion of mortgage supply.

We also demonstrate how the mutually reinforcing real estate and mortgage market booms have evolved and how the marginal effect of house prices on respectively mortgage demand (positive) and mortgage supply (negative) has become stronger over time. We show that the positive effect of house prices on mortgage pricing is particularly strong for high LTV applications, but does not vary with PTI ratios. Both demand and supply effects are smaller for refinancing than for new mortgage requests. Finally, the cautious response of lenders to high house prices is less pronounced in the Swiss "prime locations" Zurich and Geneva than elsewhere.

Our findings have important policy implications. First, we have shown that part of the house price boom has occurred for reasons exogenous to the mortgage market, although there is indeed also positive feedback from mortgage volumes to house prices. This implies that from the policy side, *house prices* can be influenced through mortgage market measures, but the influence is limited. So what is a policy maker to do who, despite the partly fundamental reasons for price increases, wishes

to exert a strong impact also on house prices? For example she may see risks to elevated house prices once fundamental factors like immigration change. That policy maker may then need to intervene also directly in the real estate market. Measures to be considered here may include changes to building permit restrictions, to the supply of public transport as an influence on which areas are well connected to jobs, subsidies for social housing, or affecting competition in the construction sector. Second, our finding that house prices have exerted a greater positive effect on mortgage *demand* than on mortgage *supply* supports the usefulness of measures targeting mortgage demand in order to affect the quantity and quality of mortgage growth. Kuttner and Shim (2013) have shown that changes to tax incentives have a particularly high probability of success here, but also helpful may be restrictions on PTI ratios. By contrast, the effectiveness of LTV restrictions would appear more questionable given the findings in this paper as well as those cited here that real estate booms are not necessarily characterized by increasing LTV ratios, for the underlying values may be increasing as fast as or even faster than mortgage amounts.

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Appendix

The purpose of this Appendix is to explore the robustness of our results. The following sections investigate (1) the role of possible interactions between mortgage demand and mortgage supply, (2) the implications of using different instruments, (3) the implications of using different sets of fixed effects, (4) how the effects of interest differ for the cantons of Zurich and Geneva, (5) the implications of excluding the areas with the highest numbers of German immigrants, and (6) the implications of clustering our standard errors in different ways.

A1.Simultaneous Equations Model

When we discuss separately the effects of house prices on respectively mortgage demand and mortgage supply, then the question arises whether demand and supply are also *directly* related. On the *Comparis* website from which we have obtained our data, banks decide whether to make an offer and at what rate only *after* demand has been set. For this reason it seems unlikely that demand would be influenced by the *request-specific* supply, while *average* supply (and expectations about it) at the time are being controlled for by our year and month fixed effects. One might wonder however whether, beyond those year and month fixed effects, there exists a direct effect of *mortgage demand* on *mortgage supply*. In that case part of the effect of house prices on supply discussed in our main results section might reflect an *indirect* effect through demand, rather than the *direct* effect of house prices alone.

To investigate this issue, Table A1 presents a Simultaneous Equations Model (SEM) with three columns displaying the three equations for respectively the outcome variables *house prices* (our usual first-stage equation), *mortgage demand* and *mortgage supply*. In this table we measure demand as the mortgage amount requested and supply as the median interest rate offered. Results are similar when we measure supply instead as the best interest rate or the number of offers a request attracts. All three equations feature the same set of control variables on household finances, object characteristics, canton fixed effects, monthly fixed effects, mortgage model fixed effects, and object type fixed effects. However, in addition to using origin-push (OP) immigration as an excluded (from the other equations) instrument for house prices, we now also use household age as an excluded instrument for mortgage demand. The reasoning behind this strategy builds on the fact that Swiss regulation requires households to reduce their LTV ratios to two-thirds by the time of retirement (or within 20 years if there are more than 20 years left until retirement). This implies that older households have fewer years to repay and hence for given incomes can afford lower mortgage amounts than younger households. Of course older households will also have accumulated more savings of their own and will have reached a higher income level, and the latter two tendencies affect not only mortgage demand but also mortgage supply. However, own savings and income are fully controlled for. Thus we consider the SEM a useful complementary exercise to investigate whether any such direct effect of demand on supply is likely to exist and to be of relevant magnitude.

Panel (A) of Table A1 displays the two first-stage effects: That of OP immigration on house prices is the same as in our main results, as *that* equation has not changed. Then Column (2) shows that indeed each additional year of household age implies a 0.9% lower requested mortgage amount. Panel (B) shows the effects of our instrumented variables on the respective outcomes. Firstly, we see in Column (3) that even after controlling for all the household and object characteristics there is indeed an (albeit quite weak) direct effect of demand on supply: Each percentage point increase in the requested mortgage amount implies a 0.00147 percentage point (0.147 basis point) higher median interest rate offered. The effects of house prices on respectively mortgage demand and mortgage supply however are not much different from those in our main results. Our finding that higher house prices expand mortgage demand is even slightly strengthened, as the effect on demand is slightly higher. The effect of house prices on the offered rate is slightly smaller, but the difference is not statistically significant.

A2.Using different instruments

More generally, readers may wonder to what extent our results depend on the exact year from which we have obtained our historical shares for distributing each year's immigrants to the 106 different MS areas. To investigate this, we have repeated our main estimates using the historical shares from different years. Table A2 shows the results for shares based on the year 2000. A look at this table, like at tables for any other year between 1995 and the first sample year 2008, reveals that while there is some small variation in the precise coefficients the general lessons described above are unaffected by exactly which historical year we use.

A3.Using different sets of fixed effects

More importantly, the question arises how our results depend on the set of fixed effects. Table A3 follows up on this, displaying only the effect of house prices on our usual set of outcomes (each displayed in a separate column) for six different sets of fixed effects (each displayed in a different panel), and always both in the IV form (upper part of each panel) and in the OLS form (lower part). Panel (B) shows the effects of omitting the monthly fixed effects. While omitting the time fixed effects matters little for the effect of house prices on mortgage demand, it does matter for the effects on supply: The effect of higher house prices on the number of offers is now stronger whereas that on interest rates now receives the opposite sign. However, it turns out that this is driven by on average lower refinancing costs in the periods with higher house prices: When we omit time fixed effects but do include a continuous control for refinancing costs (three month CHF Libor plus maturity-specific swap rates)[33], available upon request, signs of the effects on mortgage rates are again positive (and a bit larger than before). So our results our conservative choice to control for monthly fixed effects is not driving our results.

[33] For more detailed explanations on the pricing of mortgages, see e.g. Basten and Koch (2014).

Panel (C) shows the consequences of omitting the canton fixed effects which we included to control for any remaining cross-sectional differences between cantons. Completely omitting these leads to an effect of house prices on the requested mortgage volume that is a good deal larger and much closer to the OLS coefficients. The effect on the number of offers is also larger, possibly reflecting differences in the numbers of banks operating in each canton, whereas the effect on interest rates is not generally larger. When, in Panel (D), we use fixed effects for 16 different contiguous labor markets defined by the Statistics Office, rather than for the 26 different cantons (states) however, results are quite similar to the baseline ones.

Omitting mortgage model fixed effects, as displayed in Panel (E), has little effect on any of the point estimates, but removes the statistical significance of the effects on interest rates by adding noise. The reason is that mortgage model fixed effects account for general interest rate differences between mortgage models, with in general higher rates for fixed than for adjustable-rate contracts, and higher rates for contracts with long than with short duration.

Finally, Panel (F) shows the consequences of adding to our baseline set of fixed effects also fixed effects for the bank making the best offer. As would be expected given that we have fully "collapsed" the bank dimension and are working with only one observation per mortgage request, bank fixed effects makes little difference to our results.

A4. Comparing the cantons Zurich and Geneva with the 24 other cantons

Another question that may arise when interpreting our results is to what extent these are driven by Zurich and Geneva, Switzerland's largest cities. When we focus only on the two MS areas Zurich and Geneva, only about 6% of the sample are affected. Hence we now look at the entire cantons (states) around these two cities. These two (out of 26) cantons contain about one quarter of our observations. Table A4 displays regressions that interact an indicator for these two cantons with our other main regressors of interest. The first stage results in Columns (1) and (2) reveal that the marginal effect of immigration on house prices is slightly larger in these two cantons than elsewhere. That seems plausible given that the two areas already have excess demand for housing to start with.

Interestingly, Columns (4)-(6) then show that in these two cantons banks are less concerned about high house prices than elsewhere. Hence the cautious demand response appears to be driven mainly (albeit not entirely, at least with a view to the median interest rate outcome) by the other three quarters of our sample. This is interesting since Zurich and Geneva have both the highest house price levels and the highest growth rates in the past decade (especially Geneva). Nonetheless banks seem less worried here. Apparently they reason that the higher prices in Zurich and Geneva compared to other cantons are likely to persist also in a bust.

A5.Excluding the 5 MS areas with most German immigrants

In recent years Germans have constituted the largest group of immigrant inflows and one that differs from other immigrants along two dimensions. First, relative to many other large immigrant groups, Germans have been higher-skilled and hence tended to earn higher salaries. Second, the linguistic and cultural difference between Germans and Swiss Germans, while existent, is likely smaller than that between non-native (high) German speakers and Swiss Germans. Thus it is conceivable that the settlement patterns of Germans would more closely resemble those of natives than would those of other immigrants. To test whether that matters for our results, we have identified those 5 MS areas in which, on average across the six years of our sample, the annual immigration of Germans relative to the total population size was largest. These are, in the following order, Geneva (3.43%), Aigle (3.41%), Vevey (3.24%), Lausanne (2.82%) and Nyon (2.48%). Zurich, interestingly, is not amongst them: While it does in absolute number attract many Germans, it is also a generally large city (by Swiss standards) and does also attract many immigrants from many other countries. Thus in terms of our instrument, based on immigration relative to resident population size, Geneva plus some smaller places are more strongly impacted by immigration from Germany. Table A5 shows the results of omitting those five MS areas and reveals that these results do not differ much from our main results. The only relevant difference is a slightly higher effect on the mortgage amount.

A6.Different clustering of standard errors

Given the time and geographical dimensions of our sample discussed above, one may wonder whether standard errors might be correlated within time or geographical units, causing us to get our standard errors wrong. In our main specification, we computed standard errors robust to heteroskedasticity, but did not take into account possible clustering. Table A6 investigates, for our standard set of dependent variables displayed in Columns (1)-(5), how statistical significance changes relative to our baseline (Panel A) when we cluster standard errors by MS area (Panel B), year by month (Panel C), MS by year by month (Panel D), or canton by year by month (Panel E). In each panel we display in the first row our IV and in the second row our OLS estimates. For each of these variants we find that standard errors are sometimes larger and sometimes smaller than in our baseline, but in general the impact on the statistical significance of our results is quite limited.

Simultaneous Equations Model (SEM)

Table A1

			First Stage	Mortgage Demand	Mortgage Supply
			Ln House Price	Ln Mortgage Amount	Median int. rate
			(1)	(2)	(3)
(A)	Excluded Instruments	Origin Push Immigration	0.093***		
			(0.006)		
		HH age		–0.009***	
				(0.000)	
(B)	Instrumented Variables	House Price		0.570***	0.147***
				(0.064)	(0.048)
		Ln Mortgage Amount			0.056**
					(0.027)
(C)	Controls	LN Inc	0.311***	0.201***	–0.085***
			(0.007)	(0.022)	(0.018)
		LN Wealth	0.067***	0.010*	–0.027***
			(0.004)	(0.006)	(0.004)
		LN Liquidity	0.046***	0.002	–0.007**
			(0.003)	(0.004)	(0.003)
		Obligations (y/n)	0.008	0.023***	0.008
			(0.008)	(0.008)	(0.006)
		Other Real Est. (y/n)	0.037***	0.002	–0.006
			(0.008)	(0.008)	(0.006)
		House age	–0.021***	–0.008***	0.005***
			(0.001)	(0.002)	(0.001)
		Year*Month FEs	Yes	Yes	Yes
		Canton FE	Yes	Yes	Yes
		Object Type FEs	Yes	Yes	Yes
		Mortg. Model FEs	Yes	Yes	Yes
		Constant	8.771***	3.348***	0.835*
			(0.087)	(0.565)	(0.446)

This table shows the estimates of a Simultaneous Equations Model (SEM) with 3 equations. The dependent variables in equations (1)-(3) are respectively the log house price, the log mortgage amount requested, and the median interest rate offered. To be able to control directly for demand in the supply equation, we use household age as an additional excluded instruments for mortgage demand. Robust standard errors in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

Alternative instruments using 2000 rather than 1995 shares

Table A2

	First Stage	Mortgage Demand	Mortgage Supply		
	Ln House Price	Ln Mortg. Amount	Number of Offers	Best Int. Rate	Median Int. Rate
	(1)	(2)	(3)	(4)	(5)
Origin Push Immigration	0.086***				
(2000 shares)	(0.006)				
Ln House Price (instrumented)		0.543***	–1.020**	0.118**	0.156***
		(0.070)	(0.410)	(0.052)	(0.045)
Ln Income	0.310***	0.243***	0.869***	–0.081***	–0.065***
	(0.026)	(0.034)	(0.164)	(0.019)	(0.016)
Ln Wealth	0.067***	–0.023***	0.217***	–0.025***	–0.027***
	(0.006)	(0.007)	(0.038)	(0.005)	(0.004)
Ln Liquidity	0.046***	0.019***	0.120***	–0.006*	–0.005
	(0.003)	(0.005)	(0.027)	(0.004)	(0.003)
Other Fin. Obligations (y/n)	0.009	0.019**	–0.355***	0.015**	0.009
	(0.010)	(0.009)	(0.052)	(0.007)	(0.006)
Other Real Estate (y/n)	0.037***	–0.032***	–0.450***	0.015**	–0.007
	(0.009)	(0.008)	(0.049)	(0.006)	(0.006)
House Age (Decades)	–0.021***	–0.010***	–0.021**	0.005***	0.004***
	(0.001)	(0.002)	(0.010)	(0.001)	(0.001)
Constant	8.843***	2.951***	3.966	2.008***	1.407***
	(0.271)	(0.621)	(3.648)	(0.461)	(0.396)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	12753	12753	12753	12753	12753
R-sq	0.524	0.617	0.298	0.867	0.896

This table repeats our baseline regression, but now uses an instrument based on the 2000 rather than 1995 shares (see Methodology section for details). It shows in Column (1) the common 1st stage effect of origin push immigration on the house price. Column (2) shows the 2nd stage estimates of the causal effect of the house price on mortgage demand, measured by the amount requested. Columns (3)-(5) show the 2nd stage estimates of the effect on mortgage supply, as measured by respectively the number of offers a household receives, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

Different sets of fixed effects

Table A3

			First Stage	Mortgage Demand	Mortgage Supply		
			Ln House Price	Ln Mortg. Amount	Number of Offers	Best Int. Rate	Median Int. Rate
			(1)	(2)	(3)	(4)	(5)
(A)	Baseline	IV	0.093***	0.523***	–0.972**	0.148**	0.175***
			(0.007)	(0.071)	(0.414)	(0.062)	(0.055)
		OLS		0.777***	–0.367***	–0.014	–0.019**
				(0.013)	(0.063)	(0.008)	(0.008)
(B)	No Time FE	IV	0.089***	0.548***	–2.443***	–1.398***	–1.366***
			(0.006)	(0.073)	(0.454)	(0.162)	(0.160)
		OLS		0.775***	–0.432***	–0.087***	–0.096***
				(0.013)	(0.065)	(0.017)	(0.017)
(C)	No Canton FE	IV	0.095***	0.646***	–5.250***	0.232***	0.162***
			(0.005)	(0.047)	(0.391)	(0.037)	(0.030)
		OLS		0.769***	–0.235***	–0.015**	–0.019***
				(0.012)	(0.062)	(0.007)	(0.006)
(D)	Labor market FE (18) instead of Canton FE (26)	IV	0.087***	0.599***	–0.671*	0.146***	0.168***
			(0.006)	(0.070)	(0.395)	(0.053)	(0.045)
		OLS		0.776***	–0.262***	–0.011	–0.015**
				(0.013)	(0.062)	(0.007)	(0.006)
(E)	No Mortg. Model FE	IV	0.092***	0.532***	–0.936**	0.170*	0.185**
			(0.007)	(0.072)	(0.415)	(0.091)	(0.085)
		OLS		0.783***	0.783***	0.783***	0.783***
				(0.013)	(0.013)	(0.013)	(0.013)
(F)	Baseline plus Bank FE	IV	0.089***	0.509***	–0.960**	0.145***	0.175***
			(0.007)	(0.072)	(0.389)	(0.054)	(0.047)
		OLS		0.749***	–0.384***	–0.009	–0.016**
				(0.012)	(0.055)	(0.007)	(0.006)

This table shows in Column (1) the first-stage effects of origin push immigration on house prices, in Column (2) the effects of house prices on mortgage demand, and in Columns (3)-(5) the effect of house prices on mortgage supply. It shows these in Panel (A) for our baseline specification with year, month, canton (state) and mortgage model fixed effects. In P. (B) year and time fixed effects are omitted, in Panel (C) canton fixed effects are omitted. In Panel (D) canton fixed effects are replaced with labor market fixed effects. In Panel (E) mortgage model fixed effects are omitted. In Panel (F) the baseline set of fixed effects is complemented with fixed effects for the bank making the best bid. Robust standard errors in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

Cantons Zurich and Geneva vs. the other 24 cantons

Table A4

	First Stage		Mortgage Demand	Mortgage Supply		
	Ln House Price	Ln HP* I(yr>=2011)	Ln Mortg. Amount	Number of Offers	Best Int. Rate	Median Int. Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Origin Push Immigration (OPI)	0.090***	–0.003***				
	(0.008)	(0.001)				
OPI*I(ZHGE)	–0.017	0.089*				
	(0.042)	(0.052)				
Ln House Price			0.546***	–1.342***	0.217***	0.190***
			(0.083)	(0.475)	(0.069)	(0.058)
Ln HP*Indicator(ZHGE)			0.051	0.338	0.393	0.584
			(0.399)	(2.353)	(0.467)	(0.521)
I(ZHGE)	0.066	13.646***	–0.723	–4.508	–5.496	–8.124
	(0.120)	(0.150)	(5.541)	(32.711)	(6.492)	(7.247)
Ln Income	0.311***	0.023***	0.241***	0.962***	–0.121***	–0.089***
	(0.026)	(0.004)	(0.039)	(0.200)	(0.030)	(0.027)
Ln Wealth	0.067***	0.006***	–0.023***	0.237***	–0.034***	–0.033***
	(0.006)	(0.002)	(0.008)	(0.045)	(0.007)	(0.007)
Ln Liquidity	0.046***	0.003**	0.019***	0.134***	–0.012***	–0.008*
	(0.003)	(0.001)	(0.005)	(0.030)	(0.005)	(0.004)
Other Fin. Obligations (y/n)	0.008	0.003	0.019**	–0.353***	0.013*	0.007
	(0.010)	(0.003)	(0.009)	(0.053)	(0.007)	(0.006)
Other Real Estate (y/n)	0.037***	0.001	–0.032***	–0.439***	0.010	–0.009
	(0.009)	(0.003)	(0.008)	(0.050)	(0.007)	(0.006)
House Age (Decades)	–0.021***	–0.000	–0.010***	–0.028**	0.007***	0.005***
	(0.001)	(0.000)	(0.002)	(0.011)	(0.002)	(0.001)
Constant	8.839***	–0.368***	2.943***	6.947*	1.278**	1.318***
	(0.271)	(0.046)	(0.729)	(4.209)	(0.600)	(0.497)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	12753	12753	12753	12753	12753	12753
R-sq	0.524	0.998	0.618	0.289	0.852	0.880

This table tests whether the effects of interest for the cantons Zurich (ZH) and Geneva (GE) differ from those for the 24 other cantons. It shows in Columns (1) and (2) the 1st stage regressions for respectively the house price in other cantons and that in ZH and GE. Column (3) shows the 2nd stage estimate of the effect of the house price on the mortgage amount demanded. The effect for the 24 other cantons is given by the coefficient in Line 3 alone, that for ZH and GE by adding to that the coefficient from L. 4 (Log HP*Indicator). Hence that coefficient tells us how the effect for ZH and GE differed from that elsewhere. Columns (4)-(6) show analogously the effects of the two house price variables on mortgage supply, measured by respectively the number of offers received, the best and the median interest rate offered. Robust SEs in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

Excluding the 5 MS areas with most German immigrants

Table A5

	First Stage	Mortgage Demand	Mortgage Supply		
	Ln House Price	Ln Mortg. Amount	Number of Offers	Best Int. Rate	Median Int. Rate
	(1)	(2)	(3)	(4)	(5)
Origin Push Immigration	0.103***				
	(0.008)				
Ln House Price (instrumented)		2.735***	–0.945**	0.130**	0.175***
		(0.688)	(0.455)	(0.054)	(0.048)
		2.735***			
Ln Income	0.302***	(0.688)	0.850***	–0.081***	–0.068***
	(0.028)	2.735***	(0.175)	(0.020)	(0.017)
		(0.688)			
Ln Wealth	0.066***	2.735***	0.209***	–0.028***	–0.030***
	(0.006)	(0.688)	(0.042)	(0.005)	(0.005)
		2.735***			
Ln Liquidity	0.045***	(0.688)	0.131***	–0.007*	–0.005
	(0.004)	2.735***	(0.030)	(0.004)	(0.003)
		(0.688)			
Other Fin. Obligations (y/n)	0.010	2.735***	–0.367***	0.015**	0.010
	(0.010)	(0.688)	(0.056)	(0.007)	(0.006)
Other Real Estate (y/n)	0.033***	(0.688)	–0.431***	0.013*	–0.007
	(0.009)	2.735***	(0.052)	(0.007)	(0.006)
House Age (Decades)	–0.021***	2.735***	–0.019*	0.005***	0.005***
	(0.001)	(0.688)	(0.011)	(0.001)	(0.001)
Constant	8.925***	2.735***	3.042	1.852***	1.215***
	(0.287)	(0.688)	(4.113)	(0.493)	(0.432)
Year*Month FEs	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes
Object Type FEs	Yes	Yes	Yes	Yes	Yes
Mortg. Model FEs	Yes	Yes	Yes	Yes	Yes
N	11710	11710	11710	11710	11710
R-sq	0.517	0.618	0.287	0.867	0.895

This table investigates whether results differ when we omit the 5 MS areas with the highest numbers of German immigrants. It shows in Column (1) the common 1st stage effect of origin push immigration on the house price. Column (2) shows the 2nd stage estimates of the effect of the house price on mortgage demand, measured by the amount requested. Columns (3)-(5) show the 2nd stage estimates of the effect on mortgage supply, as measured by respectively the number of offers a household receives, the best interest rate offered, and the median interest rate offered. Robust standard errors in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

Different clustering of standard errors

Table A6

			First Stage	Mortgage Demand	Mortgage Supply		
			Ln House Price	Ln Mortg. Amount	Number of Offers	Best Int. Rate	Median Int. Rate
			(1)	(2)	(3)	(4)	(5)
(A)	No Clustering	IV	0.093***	0.531***	–0.974**	0.154***	0.176***
	(Baseline)		(0.007)	(0.071)	(0.412)	(0.053)	(0.045)
		OLS		0.777***	–0.351***	–0.010	–0.016**
				(0.013)	(0.063)	(0.007)	(0.006)
(B)	Clustered by MS	IV	0.093***	0.531***	–0.974	0.154**	0.176***
			(0.014)	(0.056)	(0.827)	(0.061)	(0.055)
		OLS		0.777***	–0.351***	–0.010	–0.016**
				(0.014)	(0.074)	(0.008)	(0.007)
(C)	Clustered by time	IV	0.093***	0.531***	–0.974**	0.154***	0.176***
	(year*month)		(0.007)	(0.062)	(0.420)	(0.057)	(0.043)
		OLS		0.777***	–0.351***	–0.010	–0.016***
				(0.015)	(0.102)	(0.009)	(0.006)
(D)	Clustered by MS*time	IV	0.093***	0.531***	–0.974*	0.154***	0.176***
			(0.007)	(0.072)	(0.502)	(0.054)	(0.045)
		OLS		0.777***	–0.351***	–0.010	–0.016**
				(0.013)	(0.066)	(0.007)	(0.006)
(E)	Clustered by canton*time	IV	0.093***	0.531***	–0.974**	0.154***	0.176***
			(0.007)	(0.071)	(0.422)	(0.053)	(0.044)
		OLS		0.777***	–0.351***	–0.010	–0.016**
				(0.013)	(0.073)	(0.008)	(0.006)

This table investigates how standard errors and significance change with how we cluster standard errors. It shows in Column (1) the common 1st stage effect of origin push immigration on the house price. C.(2) show sthe 2nd stage estimates of the causal effect of the house price on mortgage demand, measured by the amount requested C. (3)-(5) show the 2nd stage estimates of the effect on mortgage supply, as measured by respectively the number of offers a household receives, the best interest rate offered, and the median interest rate offered. Panel (A) shows our baseline estimates with no clustering of standard errors. In (B) they are clustered by MS area ,in (C) by year*month, in (D) by MS*year*month, and in (E) by canton*year*month. Robust standard errors in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

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