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The effect of real estate purchase subsidies on property prices

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Abstract
This paper assesses to which degree housing purchase subsidies are capitalized into property prices. Using a large-scale micro-dataset on German house prices, I exploit the introduction of a new subsidy scheme in the state of Bavaria. My difference-in-difference estimations at the Bavarian interstate border indicate that the prices of single-family homes increased by approximately 10,000 euros more in Bavarian border regions. This is consistent with a full capitalization of the subsidy. No effect is found for apartments, whose purchasers seldom qualify for the subsidy. A heterogeneity analysis confirms that the price effect is larger in segments of the real estate market with a higher exposure to the subsidy scheme. I also provide suggestive evidence that the subsidy scheme slightly stimulated construction activity. Overall, my results indicate that instead of making house purchases more affordable for families, the subsidy scheme led to a rise in house prices and mainly benefited sellers of properties.

Keywords Real estate market · Housing subsidies · Capitalization of subsidies · Property prices

JEL Classification H22 · H24 · H71 · R31 · R38

1 Introduction

Rising rents and property prices have fueled a debate on the affordability of housing in Germany, as well as in other countries around the world. This has led to calls for housing subsidies, and to the introduction of numerous measures aiming to reduce housing costs. Among others, recent years have seen the introduction of rent

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control, of a temporary accelerated depreciation schedule for the construction of residential units, and of subsidies for the acquisition of property by owner-occupiers. While many previous initiatives to make housing more affordable targeted renters and poorer households, increasing attention has lately been devoted to the costs of acquiring real estate. Both the German federal and the Bavarian state government implemented housing purchase subsidies in 2018, aiming to reduce purchase costs for owner-occupiers. These subsidies apply to both existing and newly constructed properties, with the Bavarian subsidy paid on top of the national subsidy.

Although intended to foster homeownership and to make the acquisition of property more affordable, in particular for families, housing subsidies may well exert adverse effects by driving up real estate prices. This would especially be the case if housing demand is driven up by the subsidy scheme while housing supply is rather inelastic. According to claims by the federal government, the federal subsidy is unlikely to lead to large windfall gains, and the government claims to perceive a lack of evidence on price effects of housing purchase subsidies (Deutscher Bundestag 2019). However, several features of the subsidy design speak in favor of potentially large price effects. First, due to generous income thresholds, roughly three quarters of German families with minor children—and in the case of Bavaria three quarters of households regardless of family structure—would be eligible for subsidies when buying a property. Second, federal subsidy provisions were set to expire in 2020[1]. This could in turn further stimulate housing demand between 2018 and 2020. With the German construction sector operating at its capacity limits (Gornig et al. 2019), housing supply is, however, rather inelastic. As the application window for the federal scheme is confined to three years, incentives for the construction sector to expand and develop additional capacity are limited. Contrary to claims by the government, one could thus expect a considerable pass-through into prices.

Against this background, this paper investigates to which degree direct housing subsidies are capitalized into home prices. My study is the first to assess the price effects of direct housing purchase subsidies that are not intended as a stimulus measure. For this purpose, I exploit that Bavaria, Germany's second largest federal state by population, introduced a much more extensive subsidy scheme than the federal scheme available in all states, with both broader eligibility criteria and higher benefits for Bavarian residents. I use this policy discontinuity at the Bavarian interstate border to assess the effect of subsidies on home prices in a difference-in-difference setting at the border, using a rich micro-dataset on German house prices. My findings indicate that in the second half of 2018, single-family home prices increased by roughly 10,000 euros more in Bavarian border regions than in neighboring regions of other states. These results are consistent with a full shifting of subsidies into the prices of single-family homes. In contrast, no effect can be observed for apartments. This is likely due to apartments seldom being bought by owner-occupiers who could claim the subsidy. Splitting the sample into houses with a comparatively high or low subsidization probability also points to heterogeneous effects: price effects tend

[1] As a COVID relief measure, the eligibility window was extended until March 31, 2021 on September 23, 2020.

to be larger in sectors of the real estate market with a larger exposure to the subsidy scheme. I also provide suggestive evidence that the subsidy scheme slightly stimulated construction activity of single-family houses, while possibly leading to a partial crowding-out of the construction of apartment buildings. Providing a clean identification of subsidy effects, my findings provide an important contribution to both the literature and the current policy debate at a time at which the affordability of housing is considered a key policy issue in many countries.

Evidence on housing purchase subsidies in other countries also suggests a significant capitalization into real estate prices.[2] While the German and Bavarian schemes grant flat-rate direct subsidies, other countries tend to subsidize the purchase of real estate through the tax code by granting mortgage interest deductions. Generally, most empirical evidence indicates that such tax subsidies do not increase the homeownership rate and are passed-through into property prices (see Bourassa et al. 2013 for a survey). In a general equilibrium model of the US housing market, Sommer and Sullivan (2018) show that eliminating the mortgage interest deduction would result in declining property prices, increasing homeownership and improved welfare. Hilber and Turner (2014) point out that a subsidy's effects on homeownership decisions and house prices depend on the elasticity of the housing supply: Homeownership only rises in areas with lax land-use regulations, whereas subsidies are capitalized into home prices in tightly regulated, rather inelastic housing markets. This house price effect might even result in an adverse effect on homeownership. Davis (2018) exploits the variation of US state-level tax legislation to assess capitalization effects of mortgage interest deductions on houses on both sides of the state border. His results indicate strong capitalization effects, with a one percentage point increase in the tax rate applied to mortgage interest leading to a 0.8 percent increase in house prices. Similarly, Berger et al. (2000) show a full capitalization of after-tax interest rate subsidies in Sweden. Using a Danish tax reform with a differential effect on mortgage interest deductions across tax brackets, Gruber et al. (2020) estimate long-term effects of housing tax subsidies. Their findings indicate zero effect on homeownership, but a sizable effect at the intensive margin as well as suggestive evidence that tax subsidies are capitalized into house prices. The institutional setup of a mortgage interest subsidy considerably differs from the German subsidy schemes, though. While the latter grant flat-rate direct subsidies to households below an income threshold, the size of a mortgage interest subsidy depends on both the price of a property and individual marginal tax rates. Due to the interaction between tax progressivity and the mortgage interest subsidy, high-income households with high marginal tax rates benefit the most from these subsidies.

Evidence on direct subsidies is much more scarce. Also, in contrast to the German setting, governments tend to resort to direct subsidy programs as a stimulus when the economy is weak. In the wake of the financial crisis, the USA introduced a homebuyer tax credit to counter dropping demand in the housing market (Dynan et al. 2013). While first designed with a repayment requirement, the tax credit was

[2] A related body of research addresses the price effects of real estate transfer taxes, finding strong capitalization effects (see Dolls et al. 2021).

granted as a subsidy in 2009 and 2010. In 2009, first-time homebuyers up to a certain income threshold were eligible for a refundable tax credit of 10 percent of the purchase price, capped at 8,000 USD. For most claimants, this is equivalent to a flat-rate subsidy, as in the Bavarian case. In a general equilibrium model, Floetotto et al. (2016) show that such homebuyer tax credits temporarily increase home prices and transaction volumes, but lead to negative welfare effects. Dynan et al. (2013) exploit regional variation in housing markets, finding only a small and temporary effect on sales. However, as credits were available throughout the country and the housing market underwent rapid changes, identifying a control group for an empirical analysis on prices is difficult. Similarly, the UK subsidizes the acquisition of newly built homes below a certain property value with an equity loan for up to 20% (40% for London) of the property value. Exploiting spatial discontinuities in the scope of the scheme, Carozzi et al. (2020) find strong capitalization effects in the supply-constrained London area, the size of which suggests an overcapitalization, but no effect on construction. In a region with rather elastic supply, the subsidy is instead shown to stimulate construction.

This paper proceeds as follows. Section 2 provides an overview of the subsidy schemes implemented in 2018. Section 3 describes the data sources used in my analysis. In Sect. 4, I subsequently present my methodological approach. This encompasses a description of the border difference-in-difference design and of the analysis of geodata. Results are presented in Sect. 5. Section 6 concludes.

2 Institutional background

While real estate prices were stagnating in Germany between 1995 and 2010, nominal prices have risen by roughly 50% in the last decade (Baldenius et al. 2020; Mense et al. 2019). Following the debate on increasing home prices, both the German federal government and the state of Bavaria introduced housing purchase subsidies in 2018. As the Bavarian subsidy program is supplementary to the nation-wide subsidy program, overall housing purchase subsidies are much more extensive in Bavaria.

The Bavarian housing purchase subsidy (*Bayerische Eigenheimzulage*) constitutes an immediate subsidy of 10,000 euros and is paid to eligible households who purchase or build a house or apartment for personal residence after June 30, 2018. The subsidy scheme was initially announced on May 15, 2018, leaving little time for anticipation effects. The aim of this subsidy is to encourage the acquisition of property, increase home ownership rates and create additional housing (Bayerische Eigenheimzulagen-Richtlinien 2018). The subsidy is only granted to households who have resided in or been employed in Bavaria for at least one year, and is only granted for properties located within Bavaria. Income thresholds are rather generous. While singles with taxable incomes below 50,000 euros are eligible for the subsidy, the threshold increases to 75,000 euros for married couples and to 90,000 euros for households with one child. Each additional child increases this threshold by a further 15,000 euros. That is, a family with two children would be eligible if their household income is below 105,000 euros. Overall, about three quarters of

Table 1 Scope of housing subsidies

	Bavaria			
	No children	One child	Two children	Three children
Bavarian purchase subsidy	10,000	10,000	10,000	10,000
Federal child benefit	0	12,000	24,000	36,000
Bavarian child benefit	0	3,000	6,000	9,000
Total subsidy	10,000	25,000	40,000	55,000
	Other states			
	No children	One child	Two children	Three children
Federal child benefit	0	12,000	24,000	36,000

This table indicates the maximum amount of housing subsidies in euros in Bavaria and in other German states

households meet these income requirements, and would potentially be eligible for the subsidy when purchasing or building real estate (see Sect. 3.2).

In the same year, the German federal government implemented a housing subsidy program for families. In all states, families with at least one child can claim the federal child benefit for building (*Baukindergeld*) of 1,200 euros per child and year for a period of ten years. This subsidy is available nation-wide, independent of the Bavarian housing purchase subsidy. Income thresholds coincide with the Bavarian scheme. After the subsidy was initially mentioned in the German government's coalition agreement on March 15, 2018 and agreed on by the governing parties on May 8, 2018, applications have been possible from September 18, 2018 onward. While this time frame roughly corresponds to the Bavarian subsidy scheme, housing purchases and construction permits are retroactively eligible from January 1, 2018 onward. However, this subsidy is only available for a limited time: The application window ends on December 31, 2023, while the building permit or purchase contract had to be issued by December 2020.

In addition, Bavaria introduced a top-up of the federal child benefit of 300 euros per child and year (*Bayerisches Baukindergeld Plus*). This top-up has the same residency and employment requirements as the Bavarian housing purchase subsidy, and both were announced jointly.

Table 1 indicates the maximum housing subsidy per household type in Bavaria and in other German states. Overall, eligibility conditions are broader and the average subsidy is much larger in Bavaria. Note also that the Bavarian housing purchase subsidy is paid up-front upon approval, whereas child benefits are paid over a period of ten years. This may have different implications for downpayment-constrained households as imminent payments may be more readily considered by mortgage

Table 2 Bavarian subsidies granted during eligibility period 2018-2021

	Subsidies granted	Outstanding applications	Total subsidies	Pre-existing properties
Bavarian purchase subsidy	39,741	19,505	59,246	67%
Bavarian child benefit	28,933	2,830	31,763	55%

This table shows the number of granted subsidies, the number of subsidy applications with outstanding approval, and the share of subsidies for the purchase of existing properties in overall granted subsidies on April 19, 2021. Source: Bayerischer Landtag (2021) and own calculations

brokers[3]: Subsidy payments that banks consider equivalent to equity may lead to more favorable interest rate conditions.

During the overall eligibility period, roughly 59,000 purchase subsidies were granted or waiting to be granted in Bavaria, and 32,000 households received Bavarian child benefits (Bayerischer Landtag 2021). The majority of subsidies were used for the purchase of pre-existing properties (Table 2).

A similar nation-wide scheme was abolished in 2006 due to its limited cost-effectiveness and its resulting windfall gains (Deutscher Bundestag 2005). With a volume of 11.4 billion euros in 2004, the subsidy scheme had been one of the largest subsidy schemes at the time.[4] While the policy was widely criticized on the grounds of being costly and inequitable, leading to windfall gains and potentially driving up prices (see, e.g., Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (2003); Bundesamt für Bauwesen und Raumordnung (2002); Färber (2003)), studies on this scheme are only descriptive in nature.

As opposed to other countries such as the USA, mortgage interest on owner-occupied housing cannot be deducted from income taxes. Therefore, interaction effects between housing purchase subsidies and mortgage interest taxation do not need to be accounted for. However, the federal government has introduced a temporary accelerated depreciation schedule for the construction of new residential units. This reform enables an additional 5 percent depreciation rate, subject to an upper bound, on residential units for rent constructed between September 2018 and December 2021. While this measure does not directly affect owner-occupiers, it adds to the strain on the construction sector and might drive up property prices.

These reforms are implemented at a time of historically high capacity utilization in the construction sector (Gornig et al. 2019). As the application window of the

[3] According to one of Germany's largest real estate platforms, the child benefit for building is not considered equivalent to equity by banks, also due to the long payment window: https://ratgeber.immowelt.de/a/baukindergeld-2018-wer-es-bekommt-wie-viel-es-gibt-und-was-die-voraussetzungen-sind.html

[4] As under current legislation, households with incomes below a certain threshold were eligible for the subsidy for the purchase or construction of an owner-occupied property. The subsidy was paid as a direct subsidy for a period of eight years, and consisted of a base subsidy tied to a property's acquisition costs and an additional child allowance. Until 2003, the construction of new properties was subsidized at twice the rate of the subsidy for purchases of existing homes. In 2004 to 2005, lower and uniform base subsidy levels were granted, while child supplements increased.

child benefit for building and the accelerated depreciation schedule is confined to a period of three years, the incentive for construction companies to expand capacities is limited. Against this background, one could expect a substantial effect on property prices.

3 Data and descriptive statistics

3.1 Microdata on real estate prices

My empirical analysis is based on a large and detailed micro-dataset on the German real estate market provided by the real estate consultancy firm F+B (see Dolls et al. (2021) for more details). The dataset encompasses property adverts from 140 different sources, ranging from online property portals to newspaper adverts and real estate agents. Data collection was conducted via web-scraping. The raw dataset was subject to data cleansing and consistency checks to ensure that properties listed concurrently in multiple sources are only included once.

The final dataset contains 307,517 houses and 273,786 apartments that were offered for sale within 50 km of the Bavarian interstate border in 2016 to 2018. While F+B provides data from 2005 onward, I restrict the data to the years around the reform to ensure that the estimation of pre-reform postal code fixed effects is unbiased by further state-level policies, such as long-term infrastructure investments or increases in real estate transfer tax rates. I restrict the sample to properties in the vicinity of the border, with my identification strategy resting on comparable regional time trends on both sides of the border.

Table 3 shows sample means of property characteristics for houses and apartments in the border regions of Bavaria and of neighboring states, both for the full dataset (within 50 km of the border) and the data used in my main specifications (within 25 km of the border). The main variable of interest is a property's final asking price per square meter. While F+B provides both the first and the final asking price, I focus on the latter as it is likely closer to the actual transaction price. As shown in Table 3, asking prices of houses in Bavaria amount to 299,742 euros on average, or 1,952 euros per square meter (281,645 and 1,825 euros, respectively, for the narrower sample). Although generally on a comparable level, Bavarian asking prices are slightly lower than average prices in neighboring states. These price differences are at least partly driven by the slightly higher frequencies at which houses in other states are equipped with amenities, such as a garden or a balcony. My estimations employ postal code fixed effects to account for initial price level differentials.

My data only partly includes newly constructed properties: While my data covers new properties built by developers, which are then sold to purchasers, land purchased by households for own development is not included. However, note that the majority of subsidies were granted for the purchase of pre-existing buildings (see Table 2).

Table 3 Real estate data: Summary statistics

	Houses				Apartments			
	<50km		<25km		<50km		<25km	
	Bavaria	Other	Bavaria	Other	Bavaria	Other	Bavaria	Other
Asking price	299,742	348,419	281,645	324,619	240,083	288,001	234,306	283,982
Price per sqm	1,952	2,215	1,825	2,084	2,434	2,736	2,292	2,679
Area in sqm	157.3	158.7	157.6	158.3	104.2	105.4	108.0	105.9
Number of rooms	5.3	5.3	5.3	5.3	3.3	3.4	3.4	3.4
Balcony	36.6%	39.9%	36.3%	39.1%	43.3%	43.6%	43.2%	41.8%
Garden	39.1%	43.7%	38.3%	43.1%	27.1%	28.1%	27.8%	28.9%
Basement	49.3%	49.7%	49.5%	49.4%	49.2%	51.7%	48.3%	51.6%
Parking spot	55.4%	57.9%	56.0%	56.9%	72.4%	72.6%	72.7%	71.6%
High-quality amenities	7.5%	8.1%	7.3%	8.3%	5.5%	4.8%	5.5%	5.1%
Construction year	1982	1982	1980	1983	1987	1988	1987	1988
Number of observations	109,485	198,032	65,653	85,458	84,356	189,430	46,706	80,115

This table shows summary statistics for houses and apartments within 50 km and 25 km of the Bavarian interstate border, 2016–2018. Other states encompass Baden-Württemberg, Hesse, Thuringia, and Saxony. Source: F+B and own calculations

Table 4 EVS data: Summary statistics for households by property type

	Houses	Apartments
Owner-occupiers	83.4%	21.2%
Minor children	27.8%	14.7%
Area in sqm	129.8	73.8
Number of rooms	4.6	2.7
Parking spot	86.5%	49.8%
Number of observations	24,029	34,249

This table shows summary statistics for households in the EVS data, separately for households that reside in houses and households that reside in apartments. Source: EVS 2018 and own calculations

3.2 Income and consumption survey data

I supplement my analysis with data from the German Income and Expenditure Survey (*EVS, Einkommens- und Verbrauchsstichprobe*) 2018. Conducted by the Federal Statistical Office every five years, the EVS constitutes a representative survey of German households. In the 2018 wave, the dataset encompasses 58,278 households. Among others, the survey contains data on incomes, homeownership, and living conditions. This enables me to assess the household and property characteristics of households that meet eligibility requirements for the subsidy scheme.

Table 4 presents summary statistics by property type in the EVS data. The vast majority of households living in houses are owner-occupiers, whereas only about one-fifth of households in apartments own their own property. Also, houses are more

Table 5 EVS data: Share of eligible households in Bavaria

	All households	Owner-occupiers
All Bavarian households	74.8%	66.3%
Singles	82.6%	74.0%
Childless couples	72.6%	69.1%
Households with one child	76.7%	67.3%
Households with two children	77.2%	73.6%
Households with three or more children	83.4%	81.6%
Number of observations	8,402	4,702
All German households	80.4%	69.3%
Number of observations	58,278	28,808

This table shows the fraction of Bavarian households and the fraction of German households in the EVS data that meet the Bavarian eligibility criteria for receiving housing purchase subsidies. These fractions are depicted for the overall sample of households and for the subset of owner-occupiers. Source: EVS 2018 and own calculations

frequently inhabited by families with minor children. On average, houses in the EVS sample are a bit smaller than in the advert data, but more frequently equipped with a parking spot.[5]

Table 5 indicates the fraction of Bavarian households with incomes below the eligibility threshold. While eligibility is based on gross taxable income, EVS data provides binned net household incomes. Therefore, I first apply a tax-benefit calculator on household-type specific gross income eligibility thresholds. Households with incomes below the resulting net income threshold are then classified as eligible. I use linear extrapolation to determine the fraction of eligible households whose income lies in the same income bin as the eligibility threshold.[6]

As shown in Table 5, about three quarters of households would be eligible for the subsidy when purchasing or building real estate. Among owner-occupiers, roughly two-thirds of households meet the subsidy schemes' income criteria. This group might be more indicative of households who purchase a house.

3.3 Construction permit statistics

In addition to estimating the subsidy schemes' effect on property prices, I assess whether the availability of subsidies exerts a differential effect on construction

[5] This may be due to different resale frequencies of property types, as well as to differing geographic scopes of both datasets. While Table 4 provides summary statistics on German households, Bavarian border regions are less urban than the German average. As homes in urban areas tend to be smaller, this might contribute to the difference between both data sets.

[6] Take an eligibility threshold of 4,600 euros per month, for example, which lies in the net income bin of 4,500 to 5,000 euros. In this case, calculations for Table 5 assume that 20% of households in this income bin are eligible. Results barely change, though, when either classifying all or no households in this income bin as eligible.

Table 6 Construction permit data: Summary statistics

	Residential construction	Single-family houses	Multi-family houses
Total construction permits	9.8	7.3	2.5
Per 1000 buildings	6.7	5.4	1.3

This table shows the average annual number of municipal residential construction permits for municipalities in the vicinity of 25 km of the Bavarian interstate border, 2016–2018. Source: Statistical Offices of the German Federal States and own calculations

activity. For this endeavor, I employ municipality-level administrative data on authorized residential construction projects (*Statistik der Baugenehmigungen*). This dataset is based on a full census of residential construction projects for which either a construction permit was granted, or which required a notification of municipal authorities in lieu of an application for a construction permit.[7] The dataset thus covers the universe of planned residential construction activity in the year in which formal approval was acquired. For ease of reference, I will refer to all cases as construction permits.

As larger cities issue many more construction permits than smaller municipalities, the number of residential construction permits varies between zero and several hundred permits per municipality and construction year. To account for differing municipality sizes, I scale construction activity in relation to the building stock. The latter is based on administrative data on the number of residential buildings in each municipality in 2017. Table 6 shows summary statistics on the number of construction permits for residential buildings, both in absolute terms and in relation to the overall municipal building stock.

4 Methodology

4.1 Estimation strategy

I employ a border difference-in-difference approach to estimate the price effect of the real estate purchase subsidy. This approach assesses whether property price trends diverge after the introduction of the subsidy, while controlling for different local price levels and property characteristics. Allowing for differential regional time trends, the estimation strategy also accounts for changing local conditions that may impact real estate prices. I hence estimate the following Equation:

$$p_{i,c,t} = \beta \, \text{Subsidy}_{c,t} + X_i'\theta + \delta_c + \gamma_{a(c),t} + \epsilon_{i,c,t} \tag{1}$$

[7] Whether the construction of a property requires a construction permit depends on state laws as well as local building regulations and development plans.

Subscript i indicates the respective property, t the month it was offered for sale, and c the postal code area the property is located in. As explained more thoroughly in Sect. 4.2, postal codes are allocated to cross-border regions $a(c)$ to capture regional trends. A property's total price $p_{i,c,t}$ in euros is used as the dependent variable. The main variable of interest, $Subsidy_{c,t}$, is a dummy for properties posted in Bavaria after July 2018. A positive coefficient indicates that prices on the Bavarian side of the border have risen more than prices in neighboring regions after the implementation of the subsidy scheme. The specification accounts for postal code fixed effects δ_c, which capture persistent differences in local property prices due to possibly unobserved factors, such as natural amenities, traffic accessibility, or school quality. Region-month fixed effects $\gamma_{a(c),t}$ permit differential time trends across regions. Specifications also control for property characteristics X_i, which encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms and the presence of amenities that may affect property prices. The latter include dummy variables for whether a property comes with a parking spot, a balcony, a garden or a basement. In my main specification with a full set of control variables, I additionally account for the construction year[8] and for high quality amenities.[9] Standard errors $\epsilon_{i,c,t}$ are clustered at the postal code level to account for a possible spatial correlation in local property price shocks.

My main estimations focus on house prices as houses are predominately acquired by owner-occupiers, whereas apartments tend to be more frequently bought by investors (Petkova and Weichenrieder, 2017; Deutsche Bundesbank , 2018). This is also in line with EVS data, which show that a vast majority of residents of houses are owner-occupiers, while most households living in apartments are renters. As the subsidies are only granted to owner-occupiers, I expect much stronger price effects for houses. A further specification investigates whether this prediction holds and provides results on apartment prices.

4.2 Geographic location data

Each postal code is allocated to a distance band around the Bavarian interstate border according to the minimum distance between the postal code's centroid and the border. While postal codes in the immediate vicinity of the border are arguably subject to rather comparable time trends, trends may diverge more strongly the larger the distance to the border. This implies that there is a trade-off between the number of observations and, thus, estimation efficiency on the one hand, and unbiasedness

[8] I distinguish properties using dummy variable categories for the age of the building. Categories distinguish pre-existing properties, built 2–5 or 6–10 years ago, built in 10-year building age intervals between 11 and 100 years, 101–120, 121–150, and more than 150 years ago. New houses, i.e., houses built at most one year prior to the posting, or explicitly indicated as first occupancy, are included as a distinct category to distinguish completely new houses from new homes purchased from previous tenants. Note that the sample only contains fully finished houses, excluding sales of, e.g., bare brickwork properties with potentially differing price trends.

[9] This assessment is subjective and might be partially driven by the market environment, such as sellers' market power, and might hence not be orthogonal to the reform.

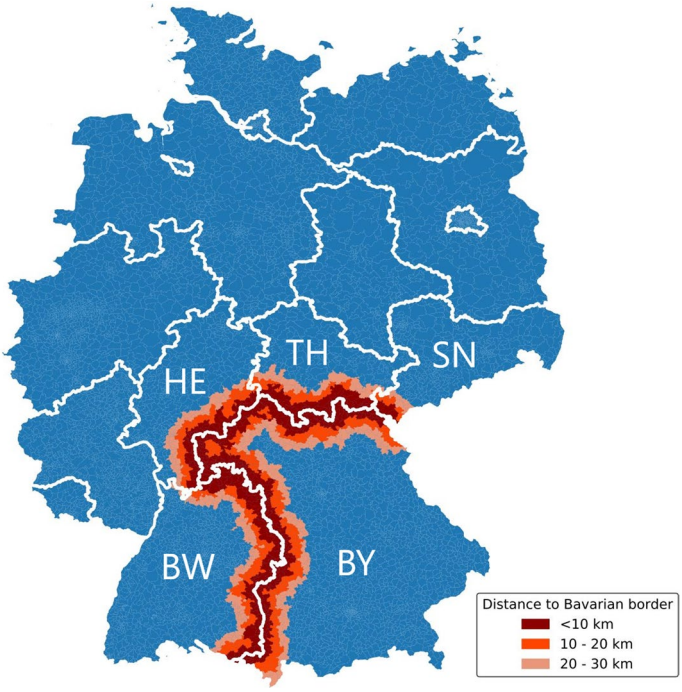

Fig. 1 Postal codes in proximity of the Bavarian border. *Notes*: This figure shows postal codes in proximity to the Bavarian interstate border and their allocation to distance bands around the border. The border states are Bavaria (BY), Baden-Württemberg (BW), Hesse (HE), Thuringia (TH), and Saxony (SN)

on the other hand. For this reason, I estimate Eq. 1 for different distance bands around the interstate border. Figure 1 showcases the assignment of postal codes to distance bands. Details on spatial units can be found in Table 16 in the Appendix.

As economic conditions may vary along the border over time, I subsequently segment border regions based on spatial planning regions (*Raumordnungsregionen*). A spatial planning region combines several NUTS-3 regions within a state according to regional structure and commuting patterns. These regions are commonly used for spatial observation and monitoring by German institutions, such as the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), but are not endowed with administrative autonomy. As spatial planning regions are defined within states, I generate cross-border regions by matching postal codes in bordering states to the closest Bavarian region. As a first step, I assign Bavarian postal codes to their respective spatial planning region along the border. Subsequently, postal codes in neighboring states are matched to the closest Bavarian spatial planning region. This matching is based on the minimum geographic distance between the postal code's centroid and the border of the spatial planning region. Using rather wide distance bands includes some Bavarian postal codes in the sample that are located in a non-border spatial planning region. These postal codes are assigned to the closest spatial planning region that adjoins the border. Figure 2 shows which region postal codes are assigned to.

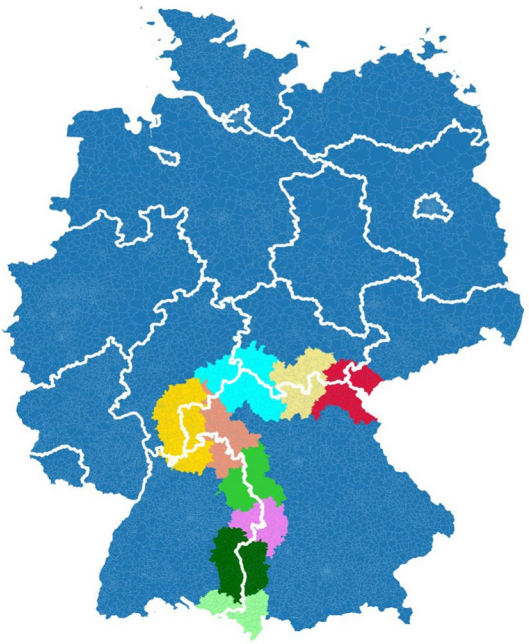

Fig. 2 Matched regions in proximity of the Bavarian border. *Notes*: This figure shows the allocation of postal codes to cross-border regions, based on the proximity to spatial planning regions in Bavaria

4.3 Accounting for tax reforms

Other concurrent reforms may possibly exert a differential impact on real estate prices. Most notably, the neighboring state of Thuringia increased its real estate transfer tax (RETT) rate from 5.0 to 6.5% at the beginning of 2017. This presumably had an impact on real estate prices in Thuringia. As shown by Dolls et al. (2021), a one percentage point increase in the real estate transfer tax rate reduces house prices by 1.5-2%, and lowers apartment prices by 3-4%. While this reform predates the introduction of housing purchase subsidies by more than a year, it likely resulted in a downward shift in prices in the pre-period, which would not be adequately captured by postal code fixed effects and cross-border regional time trends. In consequence, the estimated price effect of the Bavarian real estate purchase subsidy might be biased. Two different strategies are used to address possible confounding effects of Thuringia's RETT increase. One set of specifications drops all properties in regions intersected by the Thuringian border. That is, estimations exclude the three north-eastern regions of Fig. 2. A second set of specifications retains all observations, but introduces dummies intended to capture differential price trends in Thuringia. As indicated by Dolls et al. 's event studies, house prices begin to decline in the quarter prior to RETT reforms, with most of the pass-through taking place within half a year of a tax increase. In line with these findings, I account for RETT effects with dummies in the state of Thuringia for the quarters during which one could expect a gradual pass-through into house prices—Q4, 2016, Q1 2017, and Q2 2017—as well as a dummy variable for the time period in which house prices would be expected to have adjusted to the new price level, i.e., Q3 2017 to Q4 2018. However, the latter

Table 7 Subsidy effects on asking prices of single-family houses

Dependent variable: Property price in Euro						
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy	6960*	10794**	7232**	7321**	10673**	7305**
	(3605)	(4452)	(3610)	(3537)	(4536)	(3577)
PLZ FE	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓
Controls for Thuringia	✗	Exclusion	Dummies	✗	Exclusion	Dummies
Baseline property controls	✓	✓	✓	✓	✓	✓
Full set of controls	✗	✗	✗	✓	✓	✓
Max km to border	25	25	25	25	25	25
N	151111	113917	151111	128672	97927	128672

This table shows the differential effect of housing subsidies in Bavaria on house prices, estimated as in Eq. (1). The treatment dummy indicates properties listed in Bavaria between July and December 2018. Data is from 2016–2018. Baseline property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement. The full set of controls additionally controls for the age of the property, and for whether a property is described as having high quality amenities. Standard errors are clustered at the postal code level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

specification would not account for spillover effects of the Thuringian tax increase into border regions of Bavaria, Hesse, and Saxony. In this setting, spillover effects are more of a concern than in the case of the real estate purchase subsidy: While the subsidy requires prior residence or prior employment in the state of Bavaria, the RETT increase applies to all households regardless of their prior residence.

5 Results

This section first presents estimated property price effects that result from the introduction of the subsidy scheme. I subsequently conduct several heterogeneity analyses, differentiate between properties with a high and a low subsidization probability, and assess the effects of the subsidy scheme on construction activity.

5.1 Real estate prices

I start my analysis by estimating Eq. (1). Table 7 shows results for houses in postal codes within 25 km of the Bavarian interstate border. Specification (1) is estimated on the full sample, accounting for regional trends and controlling for property area, the number of rooms and whether a property comes with a parking spot, a balcony, a garden or a basement. Specifications (2) and (3) additionally account for a bias due to Thuringia's RETT reform, either excluding the Thuringian border region or containing dummy variables to control for the reform. Specifications (4)–(6) further

Table 8 Subsidy effects on asking prices of apartments

Dependent variable: Property price in Euro						
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy	−1380	−3281	−2703	−2865	−4152	−4013
	(3602)	(4114)	(3606)	(3076)	(3554)	(3080)
PLZ FE	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓
Controls for Thuringia	✗	Exclusion	Dummies	✗	Exclusion	Dummies
Baseline property controls	✓	✓	✓	✓	✓	✓
Full set of controls	✗	✗	✗	✓	✓	✓
Max km to border	25	25	25	25	25	25
N	126821	106970	126821	122403	103420	122403

This table shows the differential effect of housing subsidies in Bavaria on apartment prices. The treatment dummy indicates apartments listed in Bavaria between July and December 2018. Data is from 2016–2018. Baseline property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement. The full set of controls additionally controls for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

control for construction year and the presence of high-quality amenities. Coefficients are positive and significant in all specifications. Overall, my findings indicate that in the second half of the year 2018, Bavarian house prices increased by roughly 7,000 - 11,000 euros more than house prices in neighboring states. This would be consistent with a full shifting of the subsidy into property prices.

Specifications that use dummy variables to capture differential price trends in Thuringia yield lower effects than specifications that exclude Thuringian border regions. This could either be due to a lower responsiveness of prices in the predominately rural north-eastern border region[10], spillover effects between Thuringia and neighboring states, or the dummy variables not adequately capturing the timing of the pass-through of RETT reforms[11]. Further robustness checks primarily focus on specification (5), i.e., control for the full set of control variables and exclude the Thuringian border region, as I cannot rule out confounding effects of the pre-announced Thuringian RETT increase in the full sample.

In contrast to houses, effects for apartments are insignificant (see Table 8). The absence of any notable effect is consistent with expectations, given that owner-occupiers only constitute a small share of apartment residents, and investment decisions on rental properties remain unaffected by the reform. The subsidy scheme might

[10] Effects do however not differ between the medium-sized cities and more rural areas in the sample (results available on request).

[11] As opposed to other states' RETT reforms, Thuringia announced its tax increase more than a year in advance in mid-2015. This might conceivably lead to anticipation effects and diverging pass-through patterns.

Table 9 Placebo test for asking prices of single-family houses

Dependent variable: Property price in euros						
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy	−1788	364	−2047	−247	−457	−985
	(3039)	(3805)	(3301)	(3257)	(4091)	(3544)
PLZ FE	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓
Controls for Thuringia	✗	Exclusion	Dummies	✗	Exclusion	Dummies
Baseline property controls	✓	✓	✓	✓	✓	✓
Full set of controls	✗	✗	✗	✓	✓	✓
Max km to border	25	25	25	25	25	25
N	96237	74126	96237	81515	63062	81515

This table shows a placebo test for a differential effect of housing subsidies in Bavaria on house prices. The treatment dummy indicates properties listed in Bavaria between July and December 2017. Data is from 2016–2017. Baseline property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement. The full set of controls additionally controls for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

also exert a counterbalancing effect on apartment prices: Some tenants of apartments may decide to purchase a house and vacate their rental apartment in response to the subsidy. With rental revenues decreasing, this could conceivably lead to a small downward shift in the demand for apartments.

Overall, these findings confirm the validity of the house price estimations: If results for house prices were driven by a spurious correlation with other policy changes, this would likely show up in all property prices. The subsequent analysis hence focuses on houses.

5.1.1 Identification and robustness checks

My identification strategy is built on the assumption of parallel trends, assuming that in the absence of differential subsidies, property prices within a region would have followed the same trend. I undertake two approaches to verify that trends within cross-border regions are indeed comparable.

First, I conduct a placebo test on a sample limited to the pre-reform years 2016–2017. In analogy to the baseline, this specification estimates whether price trends of houses available for sale in Bavaria in the second half of the year 2017 differ from bordering states. As indicated by Table 9, the placebo test yields no significant difference in the evolution of house prices, underlining the validity of my identification strategy. For my preferred estimation strategy excluding Thuringian border regions, results are particularly close to zero.

Second, analogous to Carozzi et al. (2020), I estimate a separate monthly price index for treatment and control groups. This index is constructed by regressing

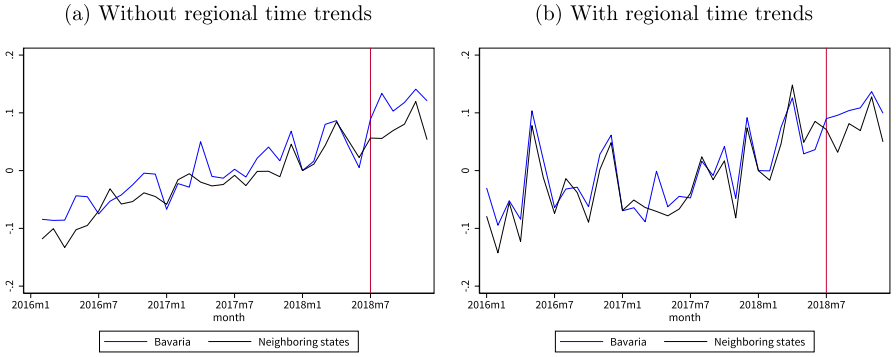

Fig. 3 Monthly time trends. *Notes*: This figure displays time trends of Bavarian and non-Bavarian houses in the sample. They are obtained by regressing log property prices per square meter on separate monthly time indicators for Bavarian and non-Bavarian properties, using the full set of control variables, as well as postal code fixed effects. Panel (b) additionally accounts for cross-border regional time trends

log square meter prices on separate monthly time indicators for Bavarian and non-Bavarian properties, using the full set of control variables, as well as postal code fixed effects. Panel (a) of Fig. 3 depicts the evolution of overall time trends, while panel (b) additionally accounts for cross-border regional time trends. That is, it captures Bavarian and non-Bavarian time trends net of regional cross-border time trends, as in my specifications. Prices on both sides of the border move in parallel, diverging after the implementation of the reform. Again, this underlines the credibility of my identification strategy.

While the reform was pre-announced quite shortly on May 15, 2018, one might nevertheless be concerned that results may be partially driven by behavioral changes in the pre-announcement period.[12] To account for this, I estimate further robustness checks without announcement periods. Specification (1) in Table 10 excludes properties listed between the initial announcement of the Bavarian subsidy scheme on May 15, 2018 and the start of the subsidy scheme on July 1st, 2018, yielding comparable estimates to the full sample. While one would expect the national subsidy scheme's announcement to exert a comparable effect on all states, I nevertheless estimate a further specification which excludes the entire period between the announcement of the national subsidy scheme as part of the coalition agreement of the German government on March 12 and July 1st. Results of specification (2) are virtually identical to the previous specification.

5.1.2 Different distance bands to the interstate border

Even though restricted by prior residency and employment requirements, sorting across the border might exert effects on real estate prices on both sides of the border.

[12] Note, for example, that in panel (b) of Fig. 3, prices in May and June 2018 are indeed slightly lower in Bavaria than in neighboring states, although the difference is small.

Table 10 Subsidy effects on asking prices of single-family houses without announcement periods

Dependent variable: Property price in euros		
	(1)	(2)
Subsidy	9944**	9694**
	(4614)	(4770)
Excluded announcement periods	Bavarian	national
PLZ FE	✓	✓
Time x region FE	✓	✓
Objective property controls	✓	✓
Full set of controls	✓	✓
Controls for Thuringia	Exclusion	Exclusion
Max km to border	25	25
N	94076	88655

This table shows the differential effect of housing subsidies in Bavaria on house prices, excluding announcement periods. The treatment dummy indicates houses listed in Bavaria between July and December 2018. Data is from 2016–2018. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

This would be the case if households who used to live in neighboring states purchased houses in Bavaria in response to the reform, or if Bavarian households who would have otherwise considered moving to a neighboring state decided to remain in Bavaria. This could possibly lead to a bias in the estimations through an effect on the control group, and would speak in favor of dropping observations close to the border. Moreover, if the reform led to changes in neighborhood composition, this may also confound the treatment effect with preferences for neighbors. Note, however, that compared to overall population size, house purchases in a given area are unlikely to substantially alter neighborhood composition. Given an overall population of more than 7 million in the vicinity of 25 kilometers to the Bavarian interstate border, the properties posted for sale constitute only a small fraction of total properties.[13]

In contrast, my identification strategy relies on the assumption that both treatment and control groups follow a similar trend, as supported by Fig. 3. The farther one moves from the border, the higher the likelihood that trends diverge. This in turn would speak in favor of relying on observations close to the border.

[13] Note that my dataset covers all major online property portals, as well as newspaper adverts and data from real estate agents, and thereby covers a significant share of the property market.

Table 11 Subsidy effects on asking prices of single-family houses excluding different distance bands to the interstate border

Dependent variable: Property price in euros					
	(1)	(2)	(3)	(4)	(5)
Subsidy	9879**	8881*	7210	9229	10232
	(4955)	(5072)	(6925)	(10505)	(7361)
PLZ FE	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓
Controls for Thuringia	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion
Baseline property controls	✓	✓	✓	✓	✓
Full set of controls	✓	✓	✓	✓	✓
Min km to border	2	5	10	15	25
Max km to border	25	25	25	25	50
N	87138	74560	50685	31420	98911

This table shows the differential effect of housing subsidies in Bavaria on house prices for different minimum distances to the interstate border. The treatment dummy indicates houses listed in Bavaria between July and December 2018. Data stems from 2016–2018. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

To provide insights on both possible effects, I conduct the estimation for different distance bands around the interstate border. For this endeavor, I employ two approaches assessing heterogeneous price effects around the border. As before, Table 11 shows results that correspond to specification (5) in Table 7, i.e., estimations that exclude border regions with Thuringia and control for the full set of property characteristics.

First, I progressively exclude postal code areas close to the border, starting from a narrow interval of 2 kilometers to the border.[14] Significance levels decrease when gradually moving away from the border (columns (1)-(5)), with coefficients slightly lowering and then slightly increasing again. The loss of significance may be due to regional time trends losing explanatory power the further one moves from the border. Column (6) also shows an estimation for properties within a range of 25 to 50 kilometers of the border. Reassuringly, the coefficient is in line with estimates for more narrow intervals, while however not attaining significance.

Reversely, I also estimate a specification that starts with properties that are very close to the border, and progressively widens the interval. As shown in Table 12, results are indeed stronger in the vicinity of the border, with coefficients peaking in

[14] Note that as my location information is on the postal code and not on the individual address level, using very narrow corridors at a range of several hundred meters only, such as in Bayer et al. (2007), is not feasible. More narrow intervals than two kilometers would only apply to a very limited number of postal code centroids.

Table 12 Subsidy effects on asking prices of single-family houses for different maximum distance bands to the interstate border

Dependent variable: Property price in euros								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subsidy	14912	20514**	16153**	13233**	14633***	9299**	8770**	9297**
	(11876)	(8833)	(6260)	(5233)	(4720)	(4285)	(4062)	(3824)
PLZ FE	✓	✓	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls for Thuringia	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion
Baseline property controls	✓	✓	✓	✓	✓	✓	✓	✓
Full set of controls	✓	✓	✓	✓	✓	✓	✓	✓
Max km to border	2	5	10	15	20	30	40	50
N	10789	23367	47242	66507	79540	115211	157998	196838

This table shows the differential effect of housing subsidies in Bavaria on house prices for different maximum distances to the interstate border. The treatment dummy indicates houses listed in Bavaria between July and December 2018. Data stems from 2016–2018. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

an interval of 5 kilometers to the border. The magnitude then gradually attenuates, stabilizing at about 9,000 euros at a distance of 30 kilometers to the border. This is again consistent with a full shifting of subsidies into property prices.

First, the apparent overshifting at a narrow interval around the border may indeed reflect sorting to some extent. Second, it may also be driven by differential characteristics of residents, for example, if the border area was more frequently inhabited by households eligible for the subsidy. Third, the common trend assumption might not hold up as well for the very narrow sample. Results of the 2017 placebo test for different distance bands point in this direction (Table 17 in the Appendix): while coefficients are insignificant for all distance bands, they are larger for narrow bands around the border.

If the reform had led to considerable sorting, i.e., to more individuals moving to Bavaria to benefit from the subsidy, this would likely reflect in population size and commuting patterns. All else equal, one would expect a stronger population growth in Bavarian municipalities adjacent to the border, and an increase in commuters residing in those municipalities. This would be the case as a large fraction of individuals would likely keep their previous employment after moving across a short distance. Hence, to check whether the subsidy led to sorting around the border, I conduct two further robustness checks assessing population changes and commuting patterns. This follows the same methodological approach as in my baseline estimation: I regress (i) log municipal population and (ii) the share of commuters, i.e., individuals working in other municipalities, in overall employed municipal residents on a treatment dummy for Bavarian municipalities, while accounting for municipality and time fixed effects. Standard errors are clustered at the municipality level. As before, I allow for differential regional time trends and estimate specifications without border regions to Thuringia. This estimation is conducted for both municipalities within 5 and within 25 kilometers of the border. As shown in Tables 18 and 19 in the Appendix, effects are insignificant and close to zero for all specifications.

5.1.3 Heterogeneity analysis

As shown by my previous analysis, the subsidy scheme's aggregate effect on house prices is consistent with a full capitalization into house prices. Yet, one could conceivably expect differential effects across segments of the property market. Notably, houses of different sizes may have a different propensity to be acquired by recipients of the subsidy. Average subsidies might also differ between house types as families are granted a higher subsidy due to the child supplement. For example, small houses with few rooms may not be attractive for families with children. In consequence, the subsidy scheme may have a comparatively lower impact on the demand curve for small houses.

Therefore, I assess whether effects differ by house size. I split the sample into small, medium-sized, and large houses, based on tertiles of the house size distribution. Treatment coefficients for all tertiles are jointly estimated, again controlling for the full set of property characteristics and excluding the Thuringian border area.

Table 13 Subsidy effects on asking prices of single-family houses: Heterogeneous effects

Dependent variable: log price per sqm				
	(1)	(2)	(3)	(4)
	Subsidy	SE	Average area	Effect in euros
Subsidy	4641	(4,487)	112	4641
Subsidy × Medium-sized houses	11131**	(4528)	146	15772
Subsidy × Large houses	7740	(9430)	220	12381

This table shows the differential effect of housing subsidies in Bavaria on house prices. The treatment dummies indicate houses listed in Bavaria between July and December 2018, distinguishing between house size tertiles. Data stems from 2016–2018. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high quality amenities. Standard errors are clustered at the postal code level.***$p<0.01$, **$p<0.05$, *$p<0.1$

Results are depicted in Table 13. Effects are positive for all house types, with significantly larger effects for medium-sized houses, i.e., properties that are possibly more frequently acquired by eligible families.

5.2 Extension and discussion

5.2.1 Analysis by likelihood of subsidization

While real estate adverts data is well suited for an analysis of aggregate price effects of subsidy schemes, it does not provide any information on a property's buyer. Therefore, I cannot directly infer whether a property's purchaser is eligible for the Bavarian housing purchase subsidy or for additional child benefits for building. This complicates assessing how a differential scope of subsidies is capitalized into prices. In order to assess whether effects differ across subsidy levels, I instead impute subsidization probabilities based on EVS data. This allows for a differential analysis of houses whose characteristics make them more or less likely to be acquired by beneficiaries of the subsidy scheme.

As a first step, I estimate a probit model for all houses in the EVS data. This estimates the probability that a house is inhabited by owner-occupiers whose incomes comply with eligibility requirements, taking account of house characteristics contained in both data sets.[15] The estimated coefficients are then used to predict subsidization probabilities in the real estate advert data. These predicted probabilities are indicative of how likely a house is to be subsidized, but should not be taken at face value.[16] Therefore, I only conduct a broad-level analysis with heterogeneous effects

[15] Variables include a polynomial of a house's area in square meters and dummy variables for the number of rooms, a parking spot, and broad construction year categories as defined in the EVS data.

[16] One reason is that the categorization of houses might be prone to omitted variable bias: Both the size of houses and the share of households above income thresholds may be correlated with the regional price level. That is, in areas with a higher initial price level, households with a given income may on average

for houses that are more or less likely to be subsidized. For this purpose, I characterize the upper half of the probability distribution, i.e., houses with subsidization probabilities above the median, as houses with a high subsidization probability. More precisely, I define a dummy variable HP_i to indicate houses with a high subsidization probability. This dummy is equal to one if the subsidization probability exceeds the median, and zero otherwise. While individual probability predictions might be biased, houses in the upper half of the distribution should on average have a higher likelihood of being subsidized. To assess differential effects for the subset of houses with a high subsidization probability, I extend Eq. (1) with an interaction term between the treatment variable and an indicator for houses with a high subsidization probability (HP_i):

$$p_{i,c,t} = \beta_1 \, \text{Subsidy}_{c,t} + \beta_2 \, (\text{Subsidy}_{c,t} * HP_i) + \nu \, HP_i + X_i'\theta + \delta_c + \gamma_{a(c),t} + \epsilon_{i,c,t} \tag{2}$$

These estimations are then conducted for households that are eligible for different subsidy levels. That is, I estimate several probit models with different dependent variables. I first assess overall eligibility for the Bavarian purchase subsidy scheme, and subsequently estimate the probability that a specific house is inhabited by a family that is also eligible for child supplements for at least one, two, or three children. As families receive higher subsidies due to the Bavarian top-up of the federal child subsidy, this helps assessing capitalization across subsidy levels.

Table 14 presents results for the heterogeneity analysis. The coefficient on the interaction term shows the extent to which the price effect for houses with a comparatively high exposure to the subsidy scheme differs from the remainder of houses in the sample. As before, the analysis includes regional time trends, excludes border regions of Thuringia, and controls for the full set of property characteristics. While no discernible effect exists when not accounting for children, effects are larger for houses that are more likely to be inhabited by families. However, significance is only attained for the sample of houses that is most likely to be inhabited by eligible families with at least one child. These findings confirm heterogeneous effects across property types, contingent on the exposure of properties to the subsidy scheme.

The subsidy is only partially capitalized in segments of the real estate market that are in comparatively lower demand by subsidy recipients. In contrast, subsidies are fully capitalized for homes that are frequently demanded by eligible families. For an average house in the high probability subsample, the price effect closely resembles

Footnote 16 (continued)
acquire smaller houses, and houses with given characteristics may on average be acquired by households with higher incomes. Lacking detailed geographic information in the EVS data, I cannot account for this correlation. Furthermore, housing choices might be endogenous to the subsidy scheme, with subsidies inducing the acquisition of larger homes (Gruber et al. 2020). Finally, while EVS constitutes a representative household sample, its results are not necessarily representative for the cross section of advertised properties. As average housing tenure may be related to property characteristics, some property types might comprise a larger share of housing transactions than of the housing stock. The probability that a specific house is inhabited by an eligible household might thus differ from the probability that the house is acquired by the very same household.

Table 14 Subsidy effects on asking prices of single-family houses: High and low subsidization probability

Dependent variable: log price per sqm				
	(1)	(2)	(3)	(4)
Subsidy	11267*	6416	7807	6811
	(5978)	(5072)	(4882)	(4220)
Subsidy × high subsidy probability	−1311	10177*	6738	9253
	(5886)	(5497)	(5412)	(5730)
Effect in euros, high probability	9956	16593	14545	16064
Eligibility criteria	overall	1+ child	2+ children	3+ children
PLZ FE	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓
Controls for Thuringia	Exclusion	Exclusion	Exclusion	Exclusion
Baseline property controls	✓	✓	✓	✓
Full set of controls	✓	✓	✓	✓
Max km to border	25	25	25	25
N	97927	97927	97927	97927
R-squared, first stage	0.0335	0.0826	0.1029	0.1281

This table shows the differential effect of housing subsidies in Bavaria on house prices, distinguishing effect for houses with high subsidization probability imputed from EVS. The treatment dummy indicates houses listed in Bavaria between July and December 2018. Data stems from 2016–2018. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

the difference between subsidies in Bavaria and in neighboring states. This again provides evidence in support of my main findings. For example, a family with one child would receive up to 25,000 euros in subsidies in Bavaria, and up to 12,000 euros in other states. While subsidy levels differ by 13,000 euros, house prices increase by a larger amount in the corresponding high probability sample. This indicates that on average, families do not benefit from the subsidy scheme as it is fully capitalized into prices. Rather, the main beneficiaries are developers and existing homeowners that benefit from the appreciation in house prices. Subsidy recipients may, however, benefit from the reform if they choose to acquire properties that are less frequently bought by eligible households and, in particular, by eligible families.

5.2.2 Effects on construction activity

Subsequently, I follow the same methodological approach as in my baseline estimation to assess the subsidy scheme's effects on construction activity: I regress the number of annual construction permits per 1000 existing buildings on a treatment dummy for Bavarian municipalities in 2018, while accounting for municipality and time fixed effects. Standard errors are clustered at the municipality level. As before, I allow for differential regional time trends and estimate specifications without border regions to Thuringia.

Table 15 Subsidy effects on construction activity

Dependent variable: number of residential construction permits per 1000 buildings						
	All		Single-family houses		Multi-apartment houses	
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy	0.184	0.381	0.326	0.524	-0.142	-0.143
	(0.365)	(0.467)	(0.330)	(0.397)	(0.112)	(0.162)
Municipality FE	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓
Controls for Thuringia	✗	Exclusion	✗	Exclusion	✗	Exclusion
Max km to border	25	25	25	25	25	25
N	3,261	2,139	3,261	2,139	3,261	2,139

This table shows the differential effect of housing subsidies in Bavaria on construction activity. The treatment dummy indicates Bavarian municipalities in 2018. Standard errors are clustered at the municipality level. ***$p<0.01$, **$p<0.05$, *$p<0.1$

Several aspects distinguish these specifications from prior estimations. First, local administrative data on construction permits is only available on an annual basis. Therefore, I am only able to estimate a treatment effect for the year 2018, pooling construction permits granted under the subsidy scheme with construction permits granted in prior months of 2018. This attenuates explanatory power vis-a-vis a setting which distinguishes construction permits granted early in the year and once the subsidy scheme became effective. Note, however, that in the absence of anticipatory effects in the first half of the year, the estimated effect should capture the change in the number of construction permits following the introduction of the scheme. Second, while price effect estimations control for a property's postal code, data on construction permits is only available at the municipal level, which often, but not always coincides with postal code areas. Larger municipalities and cities encompass several postal codes. To ensure a high degree of similarity between price and construction permit data, I weight each municipality with its number of postal codes that are located within the distance band around the Bavarian interstate border. Results are shown in Table 15. Analogous to Table 7, estimations are based on municipalities within 25 kilometers of the Bavarian interstate border.

Specifications (1) and (2) assess the effect of the subsidy scheme on overall residential construction activity. Akin to Table 7, specification (1) allows for regional trends, but does not control for the real estate transfer tax reform in Thuringia. Specification (2) additionally excludes border regions of Thuringia. Treatment effects are then decomposed into single family homes (specifications (3)–(4)) and houses with two or more apartments (specifications (5)–(6)). No significant effects can be observed for any specification. Note, however, that while the coefficients on overall construction activity and on single-family homes are positive, larger buildings with several units display a negative coefficient. While insignificant, these findings would be in line with the subsidy scheme slightly stimulating the construction of single-family homes, possibly accompanied by a partial crowding-out of multi-unit construction. As the construction sector has been operating at its capacity limits over the course of 2018, the latter could conceivably be related to price effects of the subsidy scheme on the construction sector.

5.3 Policy assessment

Overall, the subsidy scheme aimed to increase ownership rates, stimulate the construction of new housing, and make property purchases more affordable, in particular for families. As previously shown, the subsidy may have slightly fostered construction, but failed to deliver on its promise of making houses more affordable. Instead, my analysis indicates that prices have risen even more for houses purchased by eligible families.

Evidence on the effect of ownership rates is however scarce. As Germany does not have a property register, the German Statistical Office estimates homeownership rates based on a survey of roughly 1% of German households (*Mikrozensus*). Questions on the housing situation are asked every four years, with the last survey conducted in 2018. Homeownership rates do not markedly increase in 2018 (see Fig. 4 in the Appendix). Note, however, that the survey is conducted throughout the year, thus partially covering households prior to the implementation of the subsidy scheme. Estimating the effect on homeownership may provide a worthwhile avenue for further research.

A further conceivable effect may be that households purchase different property types in response to the reform. For example, Gruber et al. (2020) and Benetton et al. (2019) show that subsidies and equity schemes encourage the purchase of larger and higher quality houses. While my estimations control for housing characteristics, a shift in housing characteristics may also be of interest as an outcome of the policy scheme. However, housing size does not seem to increase in response to the reform, and the share of high-quality houses even decreases (see Table 20 in the Appendix). As this is a subjective assessment by property vendors, this effect may also be driven by changes in market conditions and advertising platforms.

All in all, my results show that directly subsidizing the purchase of properties with a flat rate subsidy does not, on average, make housing more affordable. Following the reform, families purchasing a house face higher prices. Thereby, the subsidy scheme redistributes from prospective homeowners and taxpayers toward previous home owners selling their house.

6 Conclusion

This paper assesses the effects of direct housing subsidies on property prices. Intending to reduce purchase costs for owner-occupiers, both the German federal and the Bavarian state government introduced flat-rate direct housing purchase subsidies in 2018. Exploiting that Bavaria implemented a much more extensive subsidy scheme, I quantify capitalization effects in a difference-in-difference setting across the Bavarian interstate border. Based on a rich micro-dataset on properties offered for sale, my results indicate that house prices increased by roughly 10,000 euros more in Bavarian border regions than in neighboring states. This is consistent with a full capitalization of the subsidy into the prices of single-family homes. In contrast, no significant effect arises for apartment prices, which can be attributed to apartments being rarely inhabited by owner-occupiers.

These results indicate that subsidy recipients do not necessarily benefit from the subsidy scheme. Instead, the subsidy scheme leads to an upsurge in housing demand, which is capitalized into prices. While subsidy recipients in market segments with lower price appreciation might still gain individually, prices of properties that are most likely to be inhabited by eligible households rise by the full subsidy amount. Thereby, the subsidy scheme also affects households who do not receive the subsidy, but nevertheless face higher prices. Homeowners who acquired their properties in prior years gain the most from the reform due to the appreciation of house values. On aggregate, the subsidy scheme thus redistributes from prospective toward preexisting home owners.

My results are consistent with the literature on real estate subsidies: While the German direct subsidy design substantially differs from other countries' subsidization through the tax code, substantial capitalization effects are well in line with the literature.

These findings are of high importance for the policy debate. My results show that due to the significant capitalization of subsidies into property prices, the recent subsidy scheme fails to deliver on its promise to make housing more affordable.

While my results capture short-term effects, future research might address long-term effects on house prices and construction activity. As housing supply might be more elastic in the medium and long run, long-term capitalization effects may plausibly differ from my findings.

Appendix

Spatial Units

Table 16 gives an overview of spatial units in Germany and in the sample. Germany consists of 16 states that are then broken down into counties, which again consist of municipalities.

Postal codes consist of 5 digits, with the first two indicating region and subregion, and the remaining three indicating postal areas within the region. Postal codes are often, but not always, overlapping with administrative regions. That is, while postal codes often correspond to municipalities, more populous municipalities are split into multiple postal codes, and cities generally consist of many postal codes. In turn, several small villages may jointly form a postal code.

Table 16 Spatial units

	in Germany	in 25 km sample
States	16	5
Spatial planning regions	96	20
Counties	401	48
Municipalities	11012	1093
Postal codes	8181	968

Notes: This table shows the number of spatial units in (1) in Germany overall and (2) in my sample within 25 kilometers of the Bavarian interstate border

Table 17 Placebo test: Subsidy effects on asking prices of single-family houses for different maximum distance bands to the interstate border

Dependent variable: Property price in euros								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subsidy	13220	7529	5061	159	-787	1015	759	2736
	(9700)	(6209)	(5044)	(4774)	(4438)	(3900)	(3663)	(3495)
PLZ FE	✓	✓	✓	✓	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls for Thuringia	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion	Exclusion
Baseline property controls	✓	✓	✓	✓	✓	✓	✓	✓
Full set of controls	✓	✓	✓	✓	✓	✓	✓	✓
Max km to border	2	5	10	15	20	30	40	50
N	6951	14862	30153	42603	50969	74741	102687	127731

Notes: This table shows a placebo test for the differential effect of housing subsidies in Bavaria on house prices for different maximum distances to the interstate border. The treatment dummy indicates houses listed in Bavaria between July and December 2017. Data stems from 2016–2017. Property controls encompass a polynomial of a property's area in square meters, dummy variables for the number of rooms, and indicators whether a property comes with a parking spot, a balcony, a garden or a basement, categories for the age of the property, and for whether a property is described as having high-quality amenities. Standard errors are clustered at the postal code level. *** p<0.01, ** p<0.05, * p<0.1

Table 18 Robustness check: Population changes after subsidy introduction

Dependent variable: Log municipal population				
	(1)	(2)	(3)	(4)
Subsidy	-0.0009	-0.0013	-0.0012	-0.0005
	(0.0016)	(0.0018)	(0.0010)	(0.0017)
Municipality FE	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓
Controls for Thuringia	✗	✗	Exclusion	Exclusion
Max km to border	25	5	25	5
N	3262	796	2139	600

Notes: This table shows the differential effect of housing subsidies in Bavaria on log municipal population at year end. Data stems from 2016–2018. The treatment dummy indicates Bavarian municipalities in 2018. Standard errors are clustered at the municipality level. Source: Statistical Offices of the German Federal States and own calculations. *** p<0.01, ** p<0.05, * p<0.1

Table 19 Robustness check: Changes in municipal commuter share after subsidy introduction

Dependent variable: Share of commuters in employed municipal residents				
	(1)	(2)	(3)	(4)
Subsidy	-0.0008	0.0003	-0.0004	0.0003
	(0.0016)	(0.0012)	(0.0014)	(0.0013)
Municipality FE	✓	✓	✓	✓
Time x region FE	✓	✓	✓	✓
Controls for Thuringia	✗	✗	Exclusion	Exclusion
Max km to border	25	5	25	5
N	4310	1059	2820	796

Notes: This table shows the differential effect of housing subsidies in Bavaria on the share of commuters in overall employed residents on June 30. Data stems from 2016-2019. The treatment dummy indicates Bavarian municipalities on June 30, 2019. Standard errors are clustered at the municipality level. Source: Statistical Offices of the German Federal States and own calculations. *** p<0.01, ** p<0.05, * p<0.1

Other outcome variables

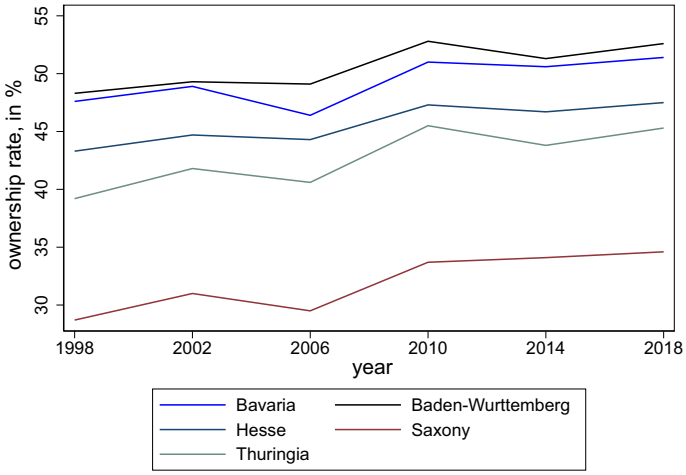

Fig. 4 Home ownership rates by state. *Notes*: This figure shows the evolution of state-level home ownership rates over time. Source: German Statistical Office based on Mikrozensus

Table 20 Changes of housing characteristics following the reform

Dependent variables	ln(area)	High-quality amenities
	(1)	(2)
Subsidy	-0.0164	-0.0125**
	(0.0119)	(0.0064)
PLZ FE	✓	✓
Time x region FE	✓	✓
Controls for Thuringia	✗	✗
Max km to border	25	25
N	103420	103420

Notes: This table shows the differential effect of housing subsidies in Bavaria on a house's area and on the presence of high-quality amenities. The treatment dummy indicates houses listed in Bavaria between July and December 2018. Data is from 2016–2018. Standard errors are clustered at the postal code level. *** p<0.01, ** p<0.05, * p<0.1

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