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Home sweet home: The effects of housing loan subsidies on the housing market in Croatia

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HRVATSKA NARODNA BANKA • CROATIAN NATIONAL BANK

Dome slatki dome: Utjecaj subvencioniranja stambenih kredita na tržište nekretnina u Hrvatskoj

Sažetak

U radu istražujemo je li subvencioniranje stambenih kredita, uvedeno u Hrvatskoj, pridonijelo povećanju cijena nekretnina u Hrvatskoj. Subvencija se provodi kroz pokrivanje dijela anuiteta u početnom razdoblju otplate stambenog kredita, sa specifičnom karakteristikom da se kućanstvo može prijaviti za subvenciju samo tijekom kratkog razdoblja. Korištenjem podataka o svim stambenim transakcijama od 2015. do kraja 2019. godine dokumentiramo da je uvođenje subvencije poremetilo uobičajenu mjesečnu dinamiku stambenih transakcija koje su postale vrlo koncentrirane u mjesecu kada su se predavali zahtjevi za subvencioniranje. Primjenjujući metodu studije događaja (engl. *event study*) nalazimo da su se cijene stanova povećale u razdoblju oko uvođenja subvencije. Kako bismo potvrdili zaključke naše osnovne specifikacije, provodimo niz dodatnih analiza. Koristimo pravila subvencioniranja stambenih kredita kako bismo dobili dodatnu kontrolnu grupu, diskutiramo ulogu međunarodnog ciklusa cijena nekretnina, te istražujemo povezanost tržišta nekretnina i turizma u Hrvatskoj. Zaključujemo da je subvencioniranje stambenih kredita djelovalo kao prociklična mjera koja je pridonijela već rastućem trendu rasta cijena stanova u Hrvatskoj. Na kraju, korištenjem regionalnih varijacija u intenzitetu subvencije koje su uvedene 2018. godine, zaključujemo da se porast cijena nekretnina odigrao u područjima i regijama s već aktivnim tržištem nekretnina.

Ključne riječi: subvencioniranje stambenih kredita, tržišna kapitalizacija, hedonistička regresija, evaluacija mjera

JEL: H24, R21, R31

Home sweet home: The effects of housing loan subsidies on the housing market in Croatia*

Davor Kunovac and Ivan Žilić

Abstract

In this paper, we explore whether a program of housing loan subsidies introduced in Croatia contributed to housing price increases. The subsidy was designed to cover a portion of annuities in the initial period of the housing loan repayment, with a distinct feature that a household could apply for the subsidy only during a month-long period. Using a dataset on housing transactions we document that the subsidy disrupted the usual intra-annual dynamics of residential transactions as they became very concentrated in the month when housing loan subsidy applications ended. Using an event study approach we find that the housing prices increased just around the introduction of the subsidy. In order to discuss possible confounders, we exploit the subsidy built-in implementation rules, discuss the role of the international housing cycle, and explore the interplay of the housing market and tourism in Croatia. We conclude that the housing loan subsidy acted as a procyclical policy that contributed to the already increasing trend of housing prices. Finally, exploiting the regional variation in the subsidy intensity, we conclude that housing price capitalization was driven by prices in areas and regions with already active housing markets.

Keywords: housing loan subsidy, price capitalization, hedonic regressions, evaluation.

JEL classification: H24, R21, R31.

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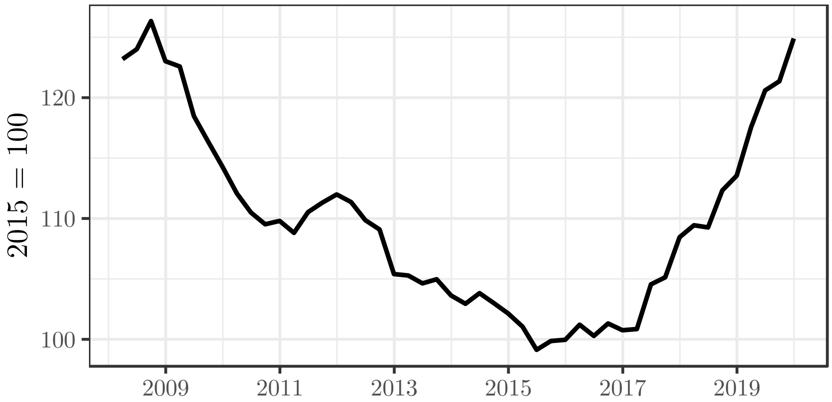
1. Introduction

The goal to make housing affordable has long been an important part of policymakers' agenda. Living space ("shelter") is a basic need, and for most households, obtaining housing is the single most important financial decision, often financed through debt. Households are usually willing to buy homes for several main reasons — economic and financial considerations, socio-demographic characteristics, and psychological and behavioral drivers (Hu, 2013). In addition to this individual perspective, high homeownership rates have many positive aspects. For example, they are often associated with lower crime rates (Dietz and Haurin, 2003), better child outcomes (Haurin et al., 2002), and more voting (DiPasquale and Glaeser, 1999). There are, on the other hand, many costs related to homeownership. Apgar (2004) and Lubell (2014) review some of the most important, including making a long-term commitment to living in a particular structure and neighborhood, investing in a nondiversified asset that can decrease in value, and less labor mobility (Caldera and Andrews, 2011).

Taking into account both positive and adverse aspects of homeownership, many countries are still willing to intervene directly into the housing market. They do so via fiscal measures in form of subsidies and taxes, direct provision of social housing and housing allowances, and regulation (Andrews and Sánchez, 2011; Andrews et al., 2011). The question remains whether these measures result in higher homeownership rates. For example, a body of research questions if the mortgage interest deductions in the US actually benefit potential house buyers (Hilber and Turner, 2014; Rappoport, 2016; Sommer and Sullivan, 2018). In this particular case, the mechanism behind the dubious effect on the homeownership rate is an increased house price which makes housing less affordable for the household on the margin of deciding on renting or buying. The housing price increase mechanism is straightforward, as Hilber and Turner (2014) point out, if the supply of housing is inelastic, rather than promoting homeownership, mortgage income deductions can be capitalized into housing prices.

Building on this literature, in this paper, we analyze whether a program of housing loan subsidies introduced in Croatia triggered housing price increases. Croatia provides an interesting setting for analyzing policies that promote homeownership due to three distinct aspects. Firstly, Croatia experienced a strong housing price increase in the last few years (Figure 1). Secondly, Croatia is characterized by a high homeownership rate at around 90% and, for example, in 2018 had the highest homeownership rate among EU member states, together with Slovakia and Romania (Eurostat, 2020a). While this high homeownership rate is determined by numerous factors, Kreitmeyer (2009) documents

Figure 1: Housing price index in Croatia



Source: Croatian National Bank and Croatian Bureau of Statistics

that Croatian households simply feel better living in their own houses, which they perceive as a more stable option, and a token of "success", while renting is often considered an insecure, and temporary solution. The last important feature is the intense tourism activity in Croatia, with more than 89 million overnight tourist stays in 2018 (Eurostat, 2020b). In addition, Croatian tourism heavily relies on private accommodation, which inherently pressures residential housing supply. For example, in 2018, at 61.3% Croatia had the second-highest share of non-hotel and non-camping beds in total bed count in the EU (Eurostat, 2020c).

The housing loan subsidy which we analyze was introduced in 2017 to make the acquisition of residential properties more affordable. The subsidy was designed to cover a portion of annuities in the initial period of the housing loan repayment. While the implementation of the subsidy changed throughout the years, the 2017 version of subsidies implied that the state would cover 50% of a monthly loan annuity for the first four years of the loan, which could be extended if the household had a child. A distinct feature of the program is that the household could apply for the subsidy only during a month-long period, usually in September and October. Given that the housing loan subsidy provided an obvious financial injection for the household, it soon become popular, accounting for around 10% of all residential transactions in Croatia. This was especially the case in areas with an already active housing market.

Using the micro dataset from the Tax Administration of the Ministry of Finance which contains the universe of residential transactions in Croatia from 2015 to 2019, we discuss the impact of housing loan subsidies on housing market dynamics and prices. We do not focus exclusively on subsidized housing transactions, but on the whole housing market as potential spillover effects might affect the broader population. We first document that the subsidy largely disrupted the usual intra-annual dynamics of residential transactions. They became very concentrated in October, a month in which the housing loan subsidy applications ended. This itself might imply that the subsidy created a market bottleneck that distorted price negotiations and the home search process as a residential transaction have to be completed in a short period. Using an event study approach that boils down to simple hedonic regression, we find that housing prices increased permanently just around the introduction of the government subsidy. Exploiting the housing loan subsidy built-in implementation rules (maximum total amount, and the unit price that can be subsidized) in combination with predetermined property characteristics (size that determines the total price, and year of build that determines unit price) we provide an additional layer of control to corroborate our baseline conclusions.

In order to assess if the observed price increase was a direct consequence of the subsidy or if there were other underlying drivers of residential prices that confound the conclusions, we provide two auxiliary analyses. In particular, we focus on the impact of international house price cycles and demand for tourism services on house prices in Croatia. Although housing, being a non-tradable good, cannot be substituted across borders, it may have a common international component. To analyze whether the observed housing price increase in Croatia was a part of broader co-movement, we analyze a common component of housing prices within many EU countries and assess the relevance of this common component for house prices in Croatia. While we find some co-movement between the common component and housing prices in Croatia, the recent increase in house prices in Croatia cannot be explained with a common housing price cycle. Therefore, our results are in line with the view that the foreign housing price cycle has not been a dominant driver of housing prices since 2017, but has, however, supported the housing price inflation. We conclude that the housing loan subsidy acted as a procyclical policy that contributed to an already increasing trend of housing prices.

In addition, we discuss whether the observed price shift in October 2017, which we relate to the introduction of the housing loan subsidy, actually came from shifts in tourism activity, which permanently puts pressure on the supply of residential properties. In order to address this, we include tourism indicators in our event study analysis, and we also inspect if other observable measures of tourism and housing (share of houses bought by foreigners, intra-regional housing transactions within Croatia) show any discontinuities around the introduction of the housing loan subsidies. We find that our baseline results and conclusions hold. Nevertheless, we argue that tourism affected the observed housing price increase. In particular, we argue that the constant pressure which tourism puts on the supply of residential properties, especially given the widespread prevalence of private accommodation in Croatia and a recent surge in short term rentals, made the supply of residential properties inelastic. Consequently, this led to price increases when the housing loan subsidy was introduced. For that reason, the housing loan subsidy acted as a procyclical trigger of additional price pressure on the already tight and inelastic housing market.

An interesting change in the implementation of the housing loan subsidy loan was introduced in 2018 when the potential subsidy rate was differentiated based on the level of development of the municipality or city where the dwelling was located. Therefore, in 2018 and 2019, instead of a 50% annuity payment coverage, subsidies were ranging from 30% for most developed cities and municipalities, up to 51% for the least developed. This setting allows us to directly estimate the effect of subsidy *intensity* using geographical discontinuities implied by the development index. We find that the relative prices of dwellings with a higher implied subsidy rate, compared with close by dwellings with a lower subsidy rate, did not change following the loan subsidy program. This finding suggests that the *intensity* did not result in any important capitalization effect. The interplay of these results indicates that the housing price increase was recorded in more affluent regions, where the housing market was more active anyways and where residential supply is more inelastic, and that less developed regions did not record any price distortions as the housing market potential was low anyway.

The next section of the paper provides more information on the institutional background, the third section details the data we use, presents the empirical approaches and results, while the last section concludes.

2. Institutional background and subsidized housing loans

In June 2017 the Croatian Parliament passed the law on housing loan subsidies (in Croatian: *Zakon o subvencioniranju stambenih kredita*).[1] By proclamation, the law aimed to incentivize demographic renewal, urban regeneration and to reverse the trend of growing emigration by easing the acquisition of residential property for young Croatians, under 45 years of age. In a nutshell, the law introduced a possibility that the state covers a portion of annuities for the initial period of housing loan repayment. The law does not regulate the housing market *per se*, households have to agree on a residential transaction and find a commercial bank to finance it, but after the contract is agreed on and a loan is approved, a household can apply for the subsidy. The subsidy is administered through the Agency for Transactions and Mediation in Immovable Properties whose role is to announce the

[1] Act on Housing Loan Subsidisation (OG 65/2017, 61/2018, 66/2019).

subsidy, collect the applications, check if they meet the criteria, and approve the subsidy. In the 2017–2019 period which we analyze, the subsidy applications were collected in a month-long period, usually in September.[2]

The first round of applications, which took place from September 4 to October 13 2017, had the following propositions:

- The housing loans could be subsidized for individuals not older than 45 years of age, who, or whose partner, do not own a flat or a house, and if they do, they intend to sell it to buy a bigger (or more appropriate) one.
- Subsidy could be used for buying apartments and flats, houses and for building houses, all of which had to have appropriate licensing permits. The subsidy was applicable up to the amount of 100,000 EUR and 1,500 EUR per square meter.[3] More expensive dwellings could also be subsidized, but only up to the aforementioned limits.
- The minimum loan maturity period for the housing loan on which the subsidy was applied to was set at 15 years, with an effective interest rate of maximum 3.75% in the first four years and up to a 10% increase for the following two years.
- If all the criteria were met and the subsidy was approved, half of the annuity during the first four years of the loan was to be subsidized.[4] The duration of subsidy could be extended for two additional years for every child the household had or adopted.

The second round of subsidies, which took place from September 3 to October 5 2018, kept most of the propositions from the 2017 round, with a few important changes:

- The amount of subsidy was municipal-specific ranging from 30 to 51%, depending on the classification of the municipality according to the development index — a composite index that groups 556 Croatian municipalities and cities into 8 development groups.[5] The percentage of subsidy was now depending on this grouping —

[2]As of 2020 the subsidy is administered through two rounds of applications, one in Spring and the other in Fall, however, due to data limitations, we do not explore the effects of 2020 rounds.

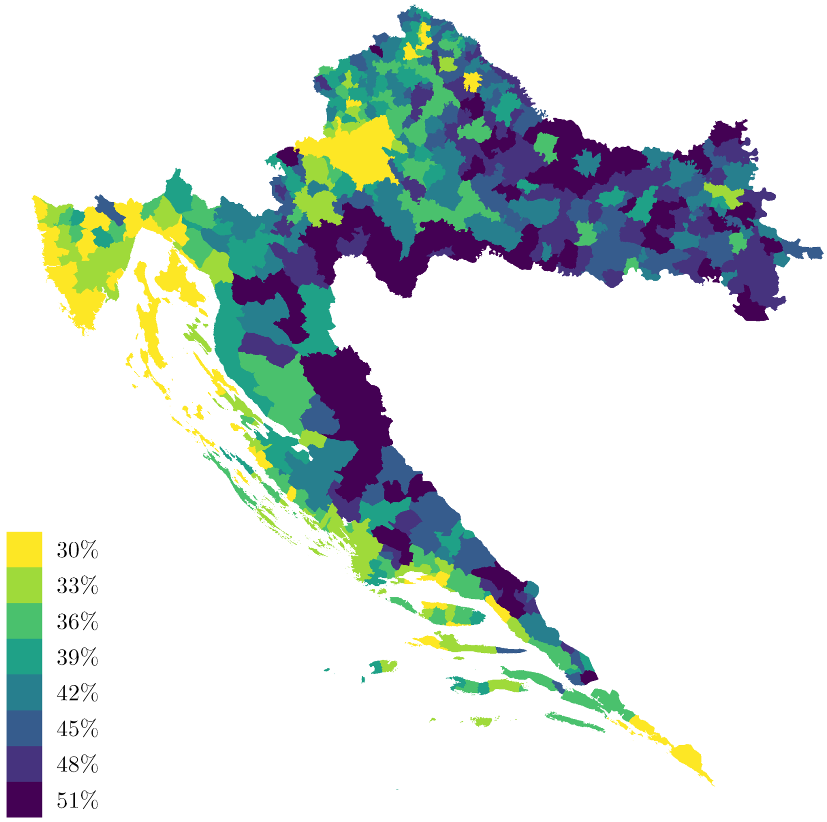
[3]The median per square meter price for apartments and flats price in Croatia in the 2015–2017 period was around 1,090 EUR while the 75 percentile was around 1,400 EUR.

[4]Extended for an additional year if any member of a household had a disability degree greater than 50%.

[5]The development index is calculated using municipal data on the average income per capita, average revenues per capita, average unemployment rate, population dynamics, tertiary education share, and demographic indicators. The current version of the development index has been applicable from the start of 2018 and will be until the start of 2021 when an updated version will be available.

the less developed the municipality is, the higher the potential subsidy. We present the potential housing subsidy loan in 2018 in Figure 2:

Figure 2: Potential housing loan subsidy in 2018



- The duration of the subsidy also increased from four to five years, and the subsidy could be extended for two additional years for every child the household had or adopted.[6]

The third round of subsidies, which took place from September 10 to October 4 2019, kept most of the propositions from the 2018 round, with only a few changes:

- If the household had an underage child before the subsidy, the duration was prolonged for a year, while if a household had a child or adopted one during subsidy, the subsidy period was prolonged for two additional years.[7]

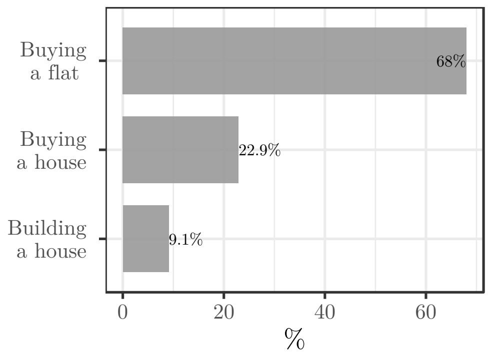
[6]Also extended for two years if any member of a household had a disability degree greater than 50%.

[7]For more details on the subsidy see Box 4 (page 35) of CNB (2019), and the official website of the subsidy (in Croatian): APN (2020c).

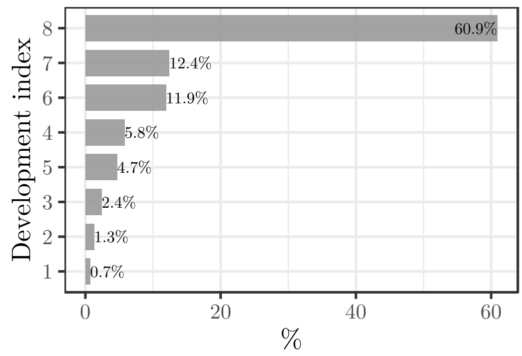
The housing loan subsidy program soon became very popular, in the 2017–2019 period, a total of 9,692 applications were submitted (2,399 in 2017, 3,033 in 2018, and 4,260 in 2019), and 9,403 were approved and financed (2,306 in 2017, 2,946 in 2018, and 4,151 in 2019), which accounts to slightly more than 12% of the housing market transaction volume. Basic descriptives on the subsidy program are presented in Figure 3:[8]

Figure 3: Housing loan subsidy in 2017 and 2018

(a) Housing loan subsidy by use



(b) Housing loan subsidy by development index



Source: Agency for Transactions and Mediation in Immovable Properties

We can see that the housing loan subsidy in 2017 and 2018 was predominately used for buying a flat (68%), and that most of the subsidies, measured in the number of subsidies, were allocated in more developed municipalities and cities (Figures 3b) — with a higher development index. An important share of these developed municipalities and cities was the City of Zagreb, a capital of Croatia, that absorbed 33.4% of subsidies, and in general accounts for around a third of the residential market in Croatia.

The reason why the housing loan subsidy was relatively popular is that it is an obvious financial injection for the household. For example, in 2017, when the subsidy was granted for 50% of annuity during the first four years, the average housing loan amounted 67,500 EUR, the average effective interest rate was at 3,30%, and the average loan maturity was 20 years.[9] Using a simple monthly annuity calculation without any deposit, and noting that these averages might not represent the average loan, we obtain that the annuity was at around 380 EUR per month. This implies that the subsidy was around 190 EUR per month across four years, which sums up to 9,120 EUR or around 10% of the total amount of credit paid. For more information on the Croatian real estate market see Tkalec et al. (2018) and Rasic et al. (2019).

[8] We do not have access to disaggregated data for 2019.

[9] You can find more info (in Croatian): APN (2020a) and APN (2020b).

3. Data and empirical approach

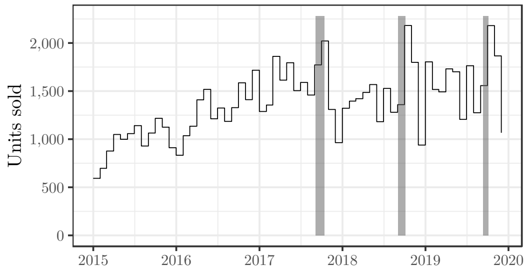
In order to analyze the effect of the housing loan subsidy on the real estate market in detail, we use micro data from the Tax Administration of the Ministry of Finance which contains the universe of residential transactions in Croatia. The database we use spans from 2015 to 2019, both including, and contains various attributes of residential transactions, such as residential property type (only house or apartment/flat), price and size, location, time of sale, year of construction (build), condition of the dwelling, as well as indicators for foreign (non-Croatian) seller and buyer. Note that we do not have access to the data on which transaction was finalized with a housing loan subsidy, which is somewhat limiting, but not to a great extent as we are interested in the effect of subsidies on the whole real estate market, including spillover effects, and not just on the treated (subsidized) transactions. As the database contains error entries, especially regarding the size of the dwelling which then translate to errors in prices per square meter, we discard transactions with the lowest and the highest 2.5% price per square meter value. The descriptive statistics are presented in the Table below. For a more detailed description of the database see Kunovac and Kotarac (2019).

Figure 4 shows the dynamics of housing transactions in the 2015–2019 period, from which we conclude that the real estate market, especially for apartments and flats which were mostly purchased through the subsidy program (see Figure 3a), has changed significantly with the introduction of the housing loan subsidies. In particular, in the month in which the application period for the subsidy ends, October 2017, 2018, and 2019, the residential market peaks in the number of transactions, followed by a sharp decline, until the next round of subsidies when the market climaxes again. This is true not only for the number of transactions, but also for the market measured in total value.[10] An interesting feature is that the total number of transactions across the whole year does not significantly change when the subsidy is introduced, implying that the housing subsidy loan redistributed and concentrated the usual volume of residential transactions in towards September and October. This in itself is an important implication of the programme, as it obviously distorted the within-year transaction volume dynamics.

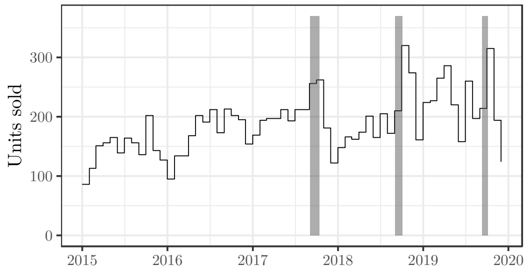
[10] Results omitted for brevity.

Figure 4: Number of apartments and houses sold

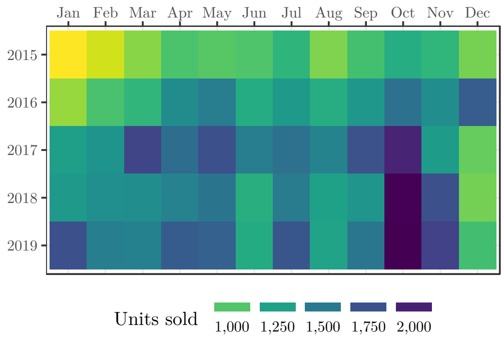
(a) Apartments and flats sold



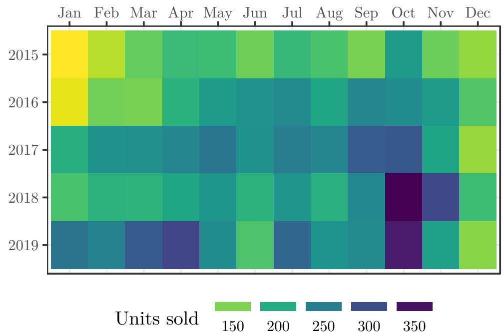
(b) Houses sold



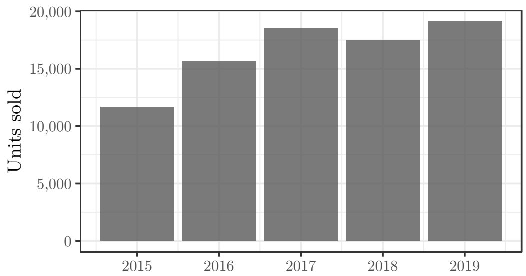
(c) Heatmap of apartments and flats sold



(d) Heatmap of houses sold



(e) Apartments and flats



(f) Houses

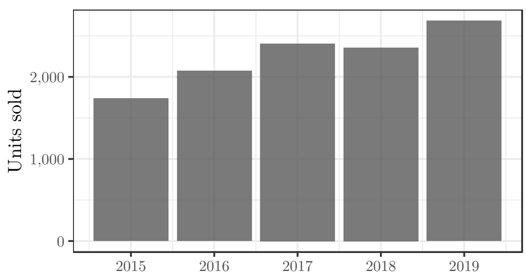


Table 1: Descriptive statistics houses and flats 2015–2019

	Flats and apartments		Houses	
Continuous variables	Mean	Std. deviation	Mean	Std. deviation
Price in EUR	68,972.75	39,912.68	78,917.80	100,537.87
Size in m^2	58.08	23.19	140.27	149.32
Age of dwelling	35.40	33.40	59.97	45.63
Dummy variables	Mean (in %)	-	Mean (in %)	-
Foreign buyer	6.79	-	15.00	-
Condition				
Adaptation needed	10.53	-	22.08	-
Good	22.76	-	13.57	-
Luxurious	0.79	-	0.20	-
Not available	65.93	-	64.15	-
Year of transaction				
2015	14.06	-	15.26	-
2016	19.14	-	18.64	-
2017	22.55	-	21.73	-
2018	21.12	-	21.04	-
2019	23.13	-	23.34	-
Observations	79,026		12,078	

3.1. Event study analysis

To explore whether the introduction of the housing subsidy loan affected prices we start with an event study analysis that boils down to hedonic regression. From Figure 4 we already see that the dynamics of residential trade changed with the subsidy, so this approach allows us analyze, in an unrestrictive manner, if the prices of dwellings also changed. In particular, we estimate:

$$ln(price_i) = \sum_{k=1}^{T} \delta_k D_{ik} + \boldsymbol{\alpha X}_i + \sum_{j=1}^{J} \beta_j B_{ij} + \epsilon_i \qquad (1)$$

where:

- $price_i$ is a price per square meter of a residential unit i.
- D_{ik} is an indicator variable taking value 1 if the residential unit i is sold in a month k, and 0 otherwise.

- X_i denotes the vector of characteristics of a residential unit i. In particular, it includes ten group dummies for the size of the dwelling, ten group dummies for the year of the build (missing values are coded as a separate group), three group dummies for the condition of the dwelling (missing values are coded as a separate group), and indicators for foreign (non-Croatian) buyer and seller.

- B_{ij} is an indicator variable taking value 1 if the residential unit i is located in a municipality j, and 0 otherwise. Therefore, β_j-s denote municipality fixed-effects that control all unobserved time-invariant characteristics at the municipal level. Given that Croatia has 556 municipalities and cities, the inclusion of these fixed-effects can control for a plethora of important real estate characteristics, such as distance to the coast (which is a good indicator of tourism), the size of the municipality, urbanization level, and time-invariant amenities, among others.

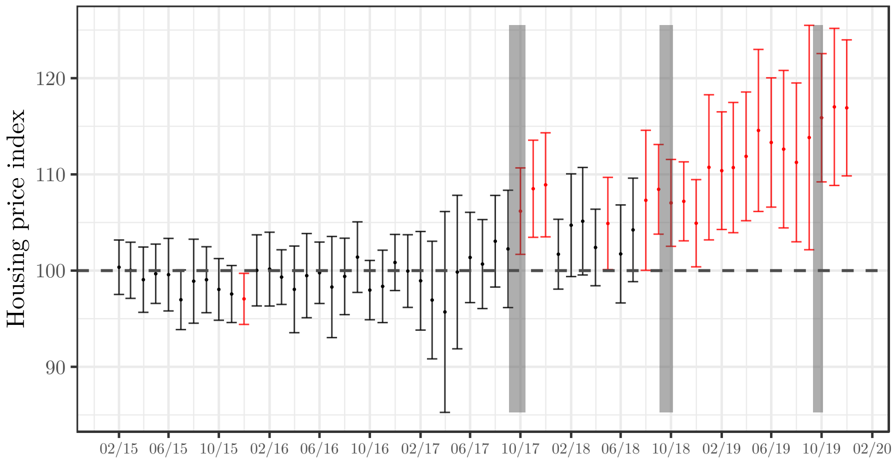
Hedonic pricing literature relies on parameters δ_k to track the evolution of house prices over time. As elaborated in related literature on 'time dummy' hedonic indices, ratio $exp(\delta_k)/exp(\delta_s)$, where s denotes base period which we use to scale time-effects, approximates the growth of a house with any set of fixed characteristics over the period $t = s$ to $t = k$. If δ_s is set to zero, $exp(\delta_k)$ compares house prices at $t = k$ to those in the base period $t = s$. Kunovac and Kotarac (2019) explain this approximation of the hedonic price index (and possible biasedness) in more detail. In the context of our analysis, by looking at $exp(\delta_k)$, we are able to detect potential price increases triggered by subsidies. One important feature of this approach is that we do not explicitly impose any structure on the time effect, we simply inspect whether these time-specific effects change when the housing loan subsidy is introduced. Note that using this we are estimating intent-to-treat of the subsidy measure, which is an attractive feature since we are interested in the spillover effects of the measure, and not only in the effect on the treated transactions. Estimates of $exp(\delta_k) \times 100$, estimated separately for apartments/flats and houses, are presented in Figure 5.[11]

These baseline results indicate that prices of residential units, especially of apartments and flats (Figure 5a), on average, significantly increased just around the time when the housing loans subsidies were introduced and when the transaction volume changed (see Figure 4). For example, in October 2017, when the first round of subsidies call closed, the prices of apartments and flats were 6.18% higher than in January 2015. The fact that this was the first significant increase of prices in the sample corroborates the interpretation that the housing subsidy loans did trigger the price increase. After the subsidy in 2017, the prices

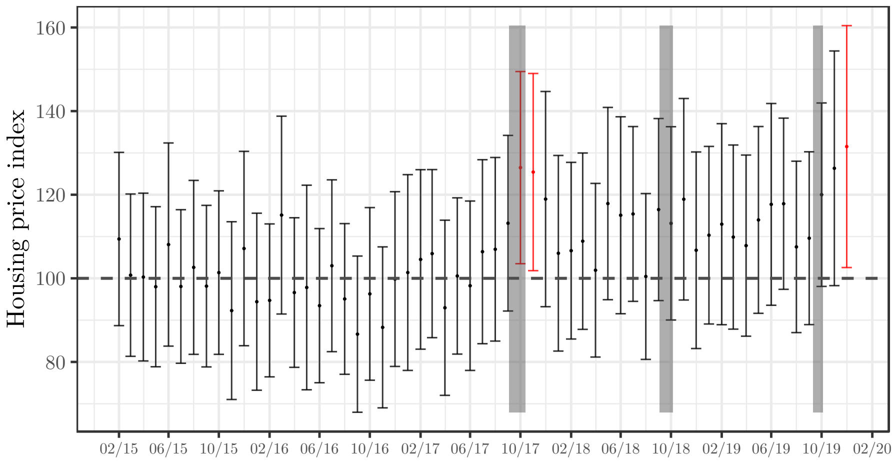
[11]These baseline estimates are also presented in Table 3 in the Appendix, while the rest of table of estimates are available upon request.

Figure 5: Event study analysis of ln of m^2 price

(a) Apartments and flats



(b) Houses



Note: Dots represent time-specific point estimates ($exp(\delta_k) \times 100$; with the reference to January 2015), while bars represent the 99% confidence intervals based on standard errors clustered at the municipal level. Covariates include ten group dummies for the size of the dwelling, ten group dummies for the year of the build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller, and municipality fixed effect. Red bars indicate effects significant at the 99% level.

of apartments went down, only to again increase in August 2018, when the next round of the measure was announced. From that point, the prices only went up, culminating in the end of 2019 when the standardized apartment prices were 16.9% higher than in January 2015. The time profile of prices of houses per square meter (Figure 5b) offers somewhat different conclusions. Apart from a temporary price increase, again in October 2017 when the subsidy was introduced (increase of a staggering 26.48%), we see no permanent price-increase effect of the housing loan subsidies. This difference in the effects on flat and house prices is rather unsurprising given that more than two thirds of subsidies were allocated for the flat purchase (at least for the 2017 and 2018, for which we have summary statistics, see Figure 3a).

To validate our baseline claims and document the subsidy effect in more detail, in the Appendix we present a county-specific event study (Figure 6), which indicates that the City of Zagreb, which absorbed a third of subsidies experienced the most severe flat price increases. Similarly, noting the uneven distribution of subsidy allocation across development groups (Figure 3b), we estimate the event study separately for different groups and conclude that only the most developed municipalities and cities (with development index 8), which absorbed most of the subsidies, experienced a permanent price increase (Figure 16). Note that for these auxiliary analyses we find a significant effect on flat prices, and lack of effect on house prices.

In order to challenge the conclusion that housing loan subsidies did change the dynamics of the housing market and led to a permanent price increase of apartments and flats, one could argue that the introduction of the subsidy and the price increase are coincidental, and/or confounded by other factors, for example, overall economic conditions. To address this caveat and corroborate our baseline results and interpretations, we exploit two built-in features of the housing loan subsides across all three years:

- The subsidy was applicable only up to 100,000 EUR which implies that smaller flats could have a greater portion of their annuity subsidized.
- The subsidy was applicable only up to 1,500 EUR per square meter which implies that less per square expensive flats could have a greater portion of their annuity subsidized.

We parametrize this in-build features using two predetermined variables:

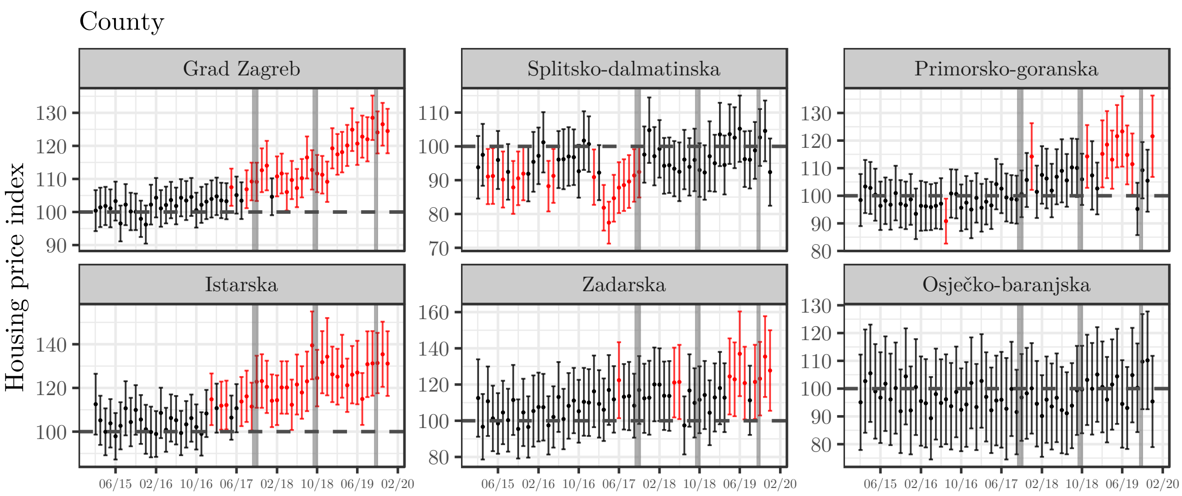
- Size of the flat in square meters.
- Year of the build of a flat as an important determinant of per square meter price.[12]

Figure 17 in the Appendix indicates that the total price in 2015 and 2016 (before the introduction of housing loan subsidies) is a function of flat size, and that the unit price is a function of the year of build. We use these two pre-subsidy patterns in conjunction with housing loan subsidy implementation rules to provide an additional layer of empirical validity — if housing loan subsidies did cause a price increase, we would observe more

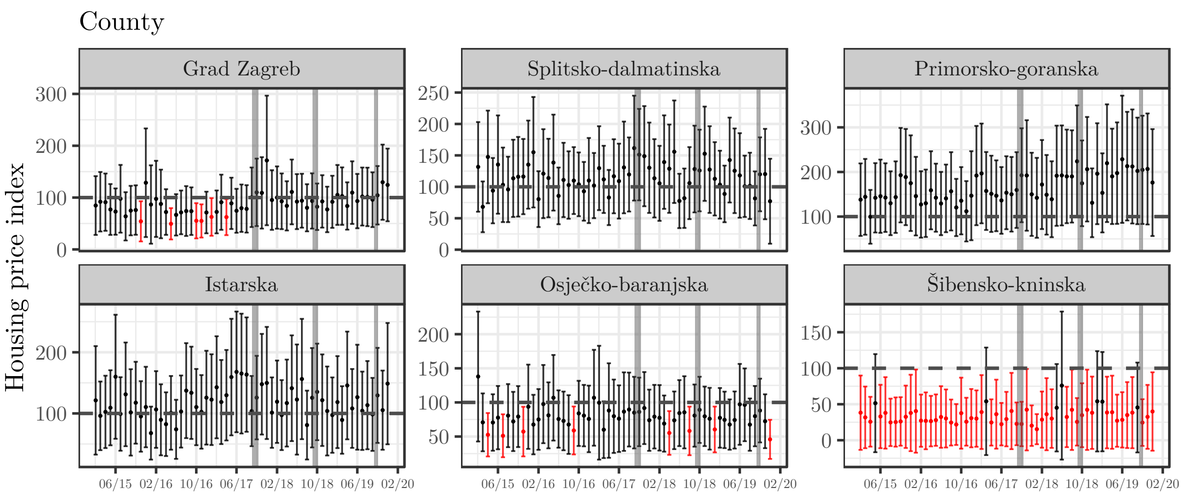
[12]Note that around fifth of transactions involving apartment and flats have a missing entry in the year of build variable.

Figure 6: County-based event study (six counties with the most transactions)

(a) Apartments and flats



(b) Houses



Note: Dots represent time-specific point estimates ($exp(\delta_k) \times 100$; with the reference to January 2015), while bars represent the 99% confidence intervals based on standard errors. Covariates include ten group dummies for size of the dwelling, ten group dummies for the year of build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller. Red bars indicate effects significant at the 99% level.

significant price shifts for relatively more subsidized flats, i.e. smaller ones and less expensive per square meter flats.

For example, in August 2017, just before the subsidy was introduced, the average apartment price per square meter across Croatia was around 1,100 EUR, implying that the whole value of a 50 square meter apartment could be applicable for the subsidy, while only 75% of a value of a 120 square meter apartment would be applicable for subsidy (*ceteris paribus*). This implies that if the observed price increase is really driven by housing subsidy loans, exploiting the fact that the size is largely a predetermined characteristic, we would observe different time-effects for differently-sized dwellings, where smaller apartments/flats would experience more profound price shifts.

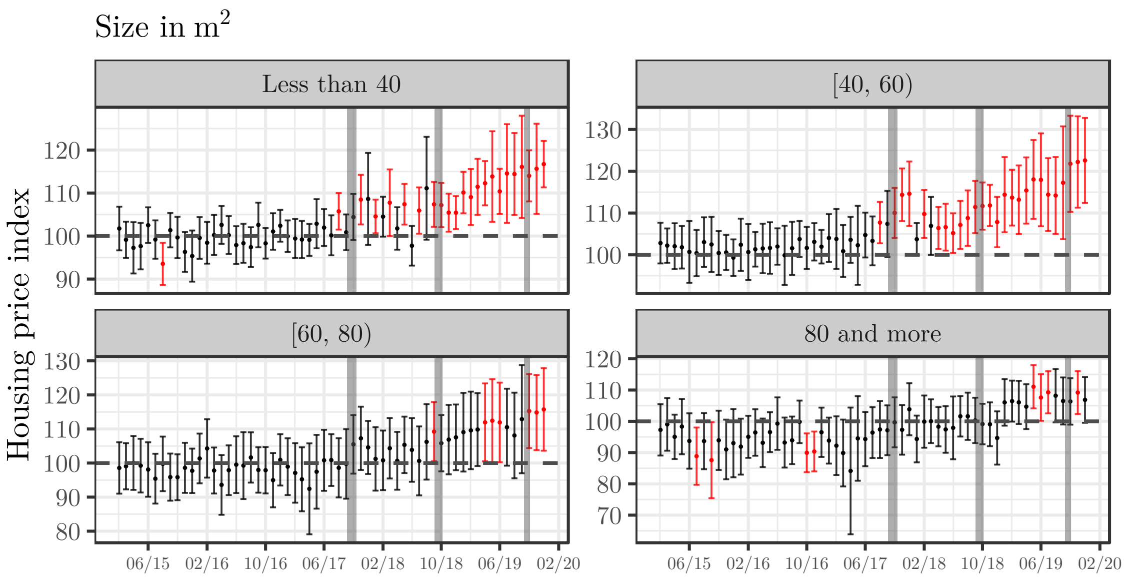
We formally inspect this by estimating Equation 1 separately for differently-sized and differently-aged apartments and flats. We use the same specification, albeit omitting the dummies for size and year of build, respectively — the results are presented in Figure 7. Panel 7a, which shows the event study analysis for differently-sized apartments and flats, indicates that prices of smaller flats increased significantly around the introduction of housing loan subsidies, while the prices of larger flats, especially the ones larger than 80 square meters, were not significantly affected by the subsidy. The same conclusion arises from Figure 7b, where more recently built apartments and flats have a smaller price shift. The interplay of these dynamics validates our initial interpretation — the introduction of housing loan subsidy significantly altered the dynamics of housing markets and increased the prices of apartments and flats. Note that our 'control' groups (bigger flats and apartments, and the ones built more recently) are also treated, albeit to a lesser extent, so we characterize obtained estimates as the lower bound of the true ones.[13]

To summarize the presented results, our event-study analysis supports the view that the change in transaction volume around the housing loan subsidy introduction triggered a permanent price increase, notably for apartments and flats which were a more frequent object of the subsidy. The fact that smaller and older flats which were relatively more treated, and flats in the more developed municipalities, which absorbed more of the subsidy, recorded more profound price increase, leans into the direction of an interpretation that the introduction of housing loan subsidies did trigger housing price changes.

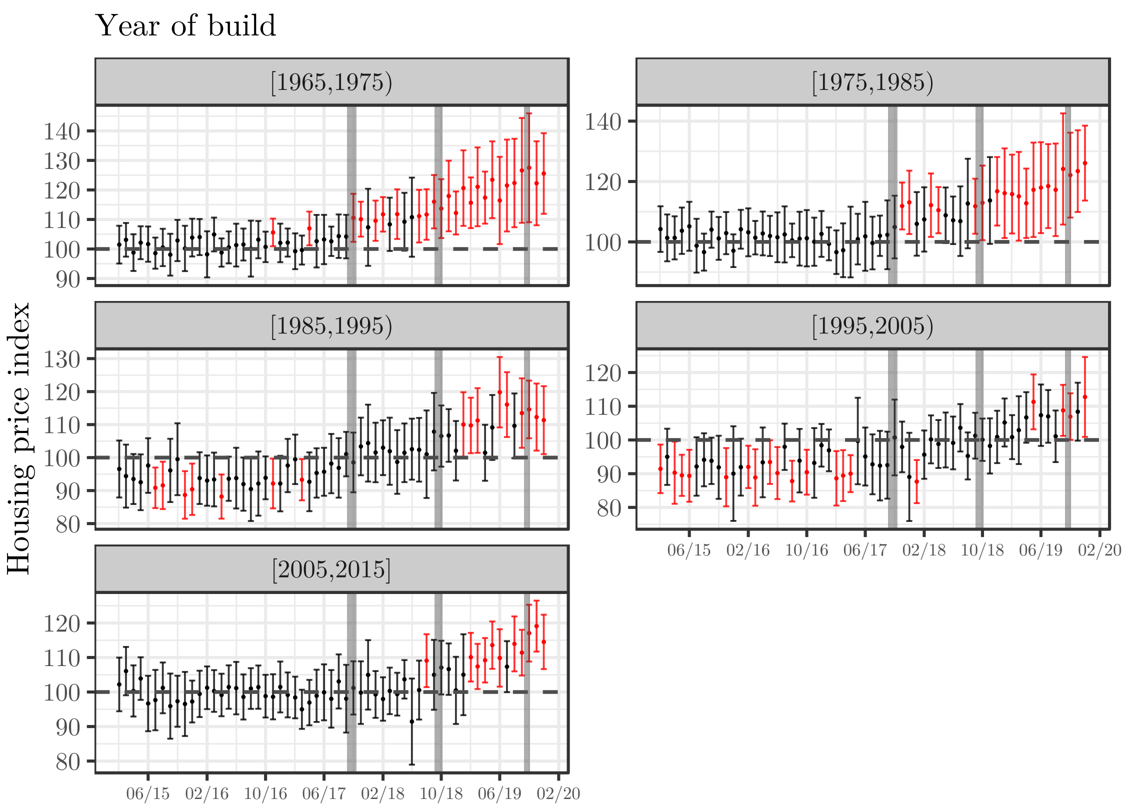
[13]Using this setup we also estimate a dynamic version of difference-in-difference. Since the results merely mirror the conclusions presented in Figure 7 we omit them due to the brevity. Note that we did not show these figures for houses — they corroborate the conclusion of no effect.

Figure 7: Event study analysis of ln of m^2 price by flat size and age

(a) Size gradient



(b) Year of build gradient



Note: Dots represent time-specific point estimates ($exp(\delta_k) \times 100$; with the reference to January 2015), while bars represent the 99% confidence intervals based on standard errors clustered at the municipal level. Covariates include ten group dummies for the year of the build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller, and municipality fixed effect. Red bars indicate effects significant at the 99% level.

3.2. International house prices

To discard the possibility that the observed price increase is driven by some other determinants, we also explore the impact of international, i.e global or European, housing price cycle. Although housing, being a non-tradable good, cannot be substituted across borders, it may have a common international component.[14] These co-movements may reflect similarities in underlying fundamentals, financing conditions or risk premia across countries, all of which can be amplified by strong economic and financial linkages (Vansteenkiste and Hiebert, 2011). A possible increase in the common component of house prices that would coincide with the introduction of government subsidies in Croatia, would therefore support the view that some factors, other than the government program, could have been dominant drivers of house prices inflation in recent years.

In order to assess the relative importance of common financial cycle and national idiosyncrasies, and implicitly underlying fundamentals, for house prices in Croatia, we extract the common cycle from house prices of a group of 20 European countries[15] and compare it to the house price cycle in Croatia.[16] Using the bandpass filter from Christiano and Fitzgerald (2003), for each of the countries, we extract a short-term frequency cycle that lasts between two and eight years. These frequencies are usually seen as standard *business cycle frequencies*. In addition, we also extract cycles with longer frequencies, between eight and fifteen years, which are usually related to house prices and, more generally, *financial cycles* (Drehmann et al., 2012; Rünstler and Vlekke, 2018; Comin and Gertler, 2006). Common components at business and financial cycle frequencies are then extracted from a group of (nominal) house prices using the principal components analysis (PCA). House prices in Croatia at the two frequencies (*business and financial cycle frequencies*) are then compared to the extracted common components to assess the relative importance of common cycle and country idiosyncrasies for house prices in Croatia. The main findings, presented in Figure 8, can be summarized as follows.

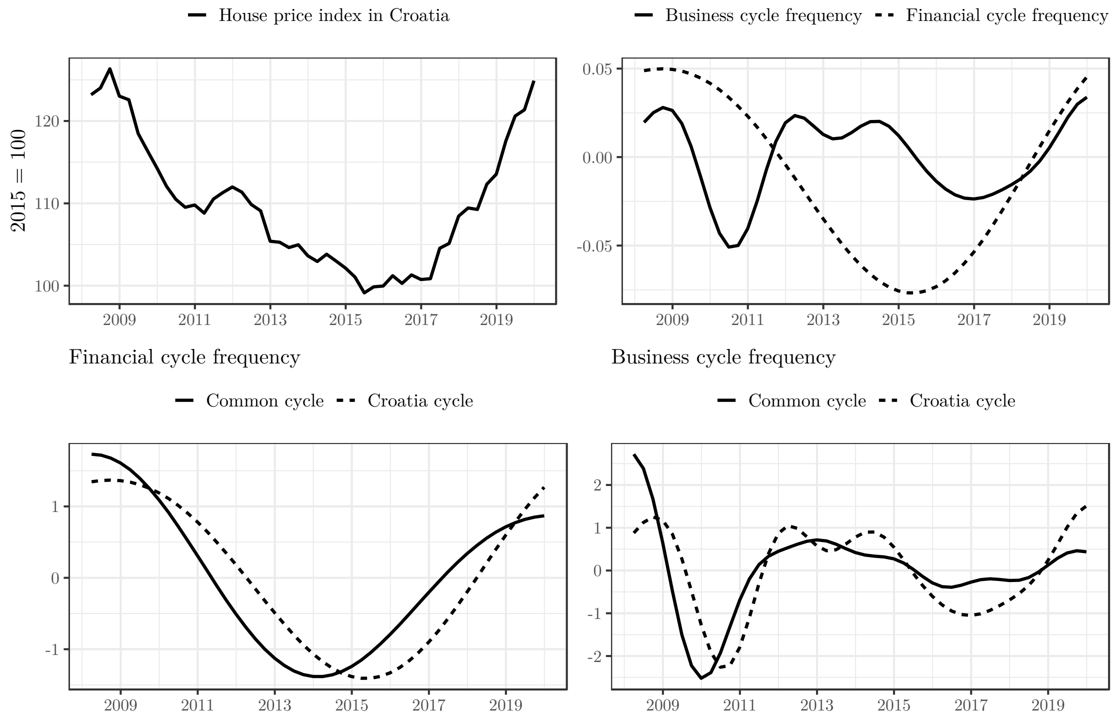
House prices in Croatia seem to have important fluctuations at both business and financial cycle frequencies (Figure 8b). In general, the first principal component at business cycle frequencies may explain 45% of total variation of all European housing prices, while at financial cycle frequencies it may explain much more — around 66%. Then, most of the

[14] Kunovac et al. (2018) and Rünstler et al. (2018) suggest that a common component in house prices is, however, of much less importance for individual countries compared to that of GDP.

[15] Countries included in our analysis are: Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden. Principal components analysis is performed using the house price data from 2008q1 to 2019q4.

[16] Comparing housing cycles in Croatia with the housing cycle across the Europe, we are implicitly accounting for fundamentals and their effect of housing market.

Figure 8: Housing price cycles



decrease in house prices since the global financial crisis, from 5% above the trend down to -8% below the trend, may be explained by movements on these medium-term frequencies. These fluctuations are well correlated with the common European component, albeit with some lag (Figure 8c). On the other hand, at the business cycle frequency, housing prices have fluctuated with smaller amplitude. The most important finding for our analysis is that, in contrast to medium term fluctuations, housing prices in Croatia show important idiosyncratic growth at business cycle frequencies that coincides with the introduction of the government subsidy (Figure 8d). More precisely, in addition to the increase along the longer frequencies, housing prices have increased from around -1.5% to around 3.5% above the trend since the start of the government subsidy program.

Overall, this simple analysis of co-movements between house price cycles in Croatia and those from other European countries supports the view that the increase in house prices in Croatia that started in 2015 was mostly in line with movements of the international financial cycle during that period. We, however, provide some evidence of additional, important inflation of house prices in Croatia that is largely specific to the domestic housing market. Most importantly, this idiosyncratic part of the house price cycle in Croatia that coincides with the introduction of the government subsidy program.

3.3. Tourism activity and housing prices in Croatia

In this section we explore whether an important determinant of the real estate market in Croatia, tourism, is confounding our results. While the notion that residential dwellings are more expensive in municipalities and cities with more tourism is an empirical fact (see, for example, Section 6 of Tkalec et al., 2018), the question, however, remains whether more tourism directly affects prices *within* a municipality, therefore at a temporal and not just geographical margin. In particular, is it possible that the observed price shift in October 2017, which we attribute to the introduction of the housing loan subsidy, actually comes from shifts in tourism activity, which permanently puts pressure on the supply of residential properties. To examine the role of tourism as a confounder in this context, we show the results of three auxiliary analyses.

Firstly, we include annual municipal-level data on tourism in our event study framework:

$$ln(price_i) = \sum_{k=1}^{T} \delta_k D_{ik} + \boldsymbol{\alpha X}_i + \sum_{j=1}^{J} \beta_j B_{ij} + \gamma T_i + \epsilon_i \qquad (2)$$

where k is now defined as a yearly time-frame, T_i denotes per capita tourist overnight stays in municipality j at time k, so the the γ parameter[17] captures the effect of tourism on residential prices.[18] Using this framework we are able to control for municipality-specific dynamics of tourism. If tourism activity is driving the observed housing price increases, one would expect that the magnitude and significance of the coefficient next to the time dummies would change with the inclusion of tourism variables. The main restriction here is that we do not have monthly or quarterly tourism data on a municipal level that spans across our time frame, so in order to avoid arbitrary assumptions on the seasonal pattern, we collapse our analysis on the annual level. Figure 9 presents the results with and without the inclusion of tourism, separately for apartment and flats. The magnitude of point estimates with and without the inclusion of tourism is quite similar, and all of the main conclusions hold — housing prices significantly increase in 2017 even if we control for tourism.

To explore the effect of tourism on housing prices more flexibly, we also estimate the time-specific coefficient next to tourism. In particular, we estimate Equation 2 but with five tourism variables, one for each year of the sample. The results of this specification, along

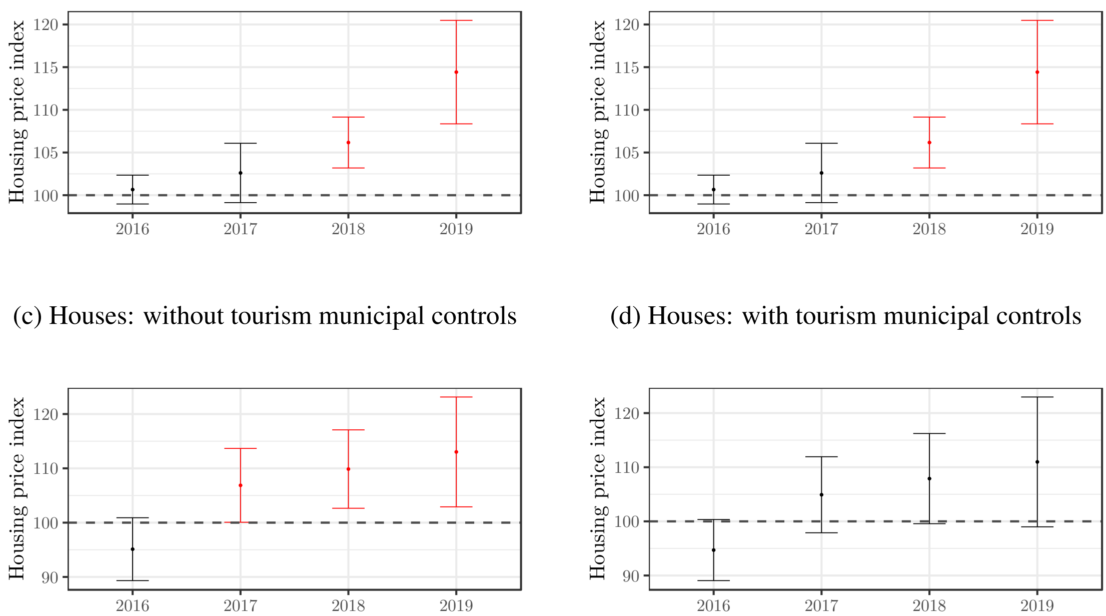
[17] Note that we, in order to allow nonlinearities, include a linear and a nonlinear tourism measure in the specification.

[18] No tourist overnight stays, in at least one of the years, were recorded in 236 out of 556 municipalities, so they are excluded from the analysis. Note, however, that the remaining 320 municipalities account for around 95% of all residential transactions in the sample.

with the baseline from Equation 2, are presented in Table 2. The clear conclusion from Table 2 is that, even if we control for tourism activity in different specifications, there is a significant increase in housing prices, especially for apartments and flats. Interestingly enough, in all the columns of Table 2, the coefficient next to tourism is not significant in explaining housing prices. This is because we include municipality fixed effects in the specifications, which capture the geographical characteristics, most notably, distance to the coast. Therefore, once we control for coastal municipalities, more tourism does not capitalize into higher housing prices. Given that geography is not a policy function, while tourism activity is, we argue this is a useful insight that corroborates our baseline conclusions. In addition, column (2) shows that the effect of tourism on housing prices, estimated separately for every year, does not change throughout the sample.

This results is quite unsurprising if we look at the dynamics of tourism growth and residential price increases in Croatia (see Figure 10).

Figure 9: Year event study analysis of ln of m^2 price



(a) Apartments: without tourism municipal controls

(b) Apartments: with tourism municipal controls

(c) Houses: without tourism municipal controls

(d) Houses: with tourism municipal controls

Note: Dots represent time-specific point estimates ($exp(\delta_k) \times 100$; with the reference to 2015), while bars represent the 99% confidence intervals based on standard errors clustered at the municipal level. Covariates include ten group dummies for size of the dwelling, ten group dummies for the year of build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller and, municipality fixed effect and municipal level tourist overnight stays (panel b). Red bars indicate effects significant at the 99% level.

Secondly, tourism might affect housing prices in ways other than overnight stays. As Croatia is becoming a more popular destination, it is plausible that foreigners (non-

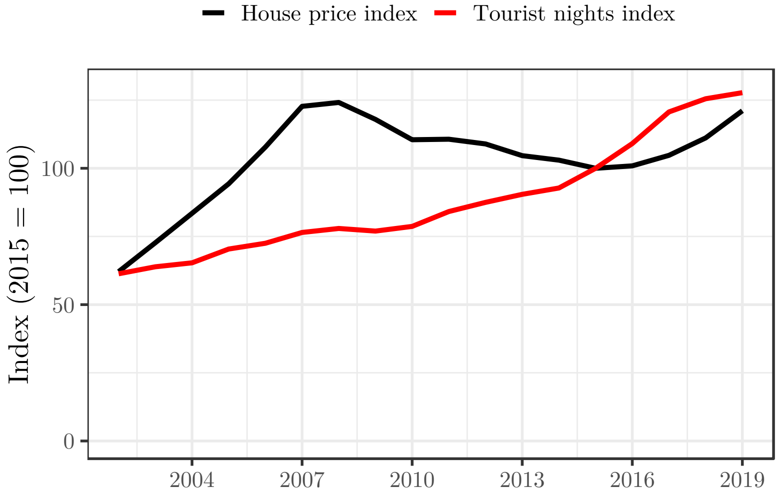
Table 2: Comparison of two different specifications with tourism

	Flats and apartments		Houses	
	(1)	(2)	(3)	(4)
Time specific effects (with respect to the 2015)				
2016	0.006	0.010	−0.054*	−0.070**
	(0.010)	(0.009)	(0.030)	(0.036)
2017	0.024	0.022	0.048	0.028
	(0.021)	(0.021)	(0.033)	(0.034)
2018	0.058***	0.058***	0.076**	0.053
	(0.019)	(0.017)	(0.039)	(0.034)
2019	0.133***	0.138***	0.104*	0.098*
	(0.033)	(0.030)	(0.054)	(0.053)
Tourism	0.0002		0.001	
	(0.001)		(0.002)	
Tourism squared	−0.00000		0.00000	
	(0.00000)		(0.00000)	
Tourism specific effects				
2015		0.0004		−0.00002
		(0.001)		(0.002)
2016		0.0003		0.0002
		(0.001)		(0.001)
2017		0.0004		0.0004
		(0.001)		(0.001)
2018		0.0004		0.0004
		(0.001)		(0.001)
2019		0.0003		0.0002
		(0.001)		(0.001)
Ten size dummies	Yes	Yes	Yes	Yes
Ten age dummies	Yes	Yes	Yes	Yes
Three condition dummies	Yes	Yes	Yes	Yes
Foreign buyer and seller dummies	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Observations	78,001	78,001	11,656	11,656
Adjusted R^2	0.453	0.453	0.477	0.477
Residual Std. Error	0.298	0.298	0.706	0.706

Note: Table presents estimated coefficients from Equation 2 (Columns (1) and (3)) and from the specifications with the time-specific effect of tourism (Columns (2) and (4)). Standard errors are clustered at the municipal level.

*p<0.1; **p<0.05; ***p<0.01

Figure 10: Housing price index and tourism



Note: House price index is an official quarterly based index calculated by the Croatian National Bank and the Croatian Bureau of Statistics. Tourist nights index represents the dynamics of overnight stays reported on an annual level by the Croatian Bureau of Statistics.

Croatians) with more purchasing power are willing to buy more properties in Croatia therefore raising the prices and/or spilling over their domestic housing price cycle to Croatia. We can explore this channel by inspecting the share of transactions with a non-Croatian buyer. Figure 11 indicates that the share of transactions with a foreign buyer is rather stable across time, fluctuating at around 10% of the total number of transactions — if anything, the number actually declines from 2018 onwards.

And lastly, using similar reasoning, given the widespread practice of renting private dwellings for tourism, it is plausible that individuals from coastal regions are obtaining enough financial assets to buy residential properties across Croatia, potentially raising housing prices.[19] For example, someone from coastal Split might, after a successful tourist season, buy a flat in continental Zagreb. Given that we know the municipality of the transaction and the municipality of residence of the buyer we can infer if this dynamic is important. To make this more tractable, we split 556 municipalities and cities into three groups: coastal, Zagreb and other (you can see the division from Figure 2 in Kunovac and Kotarac, 2019). Note that in this analysis we exclude foreign buyers as we are interested in intra-Croatian dynamics. We then plot time series across nine combinations — three locations of transactions and three locations of residence of buyers — to see if there is something systematically different just around the time when the housing loan subsidy is introduced; the results are presented in Figure 12. While this analysis does not capture

[19] In 2018, at 61.3% Croatia had the second highest share of non-hotel and non-camping beds in total bed count in the EU, see Eurostat (2020c).

the totality of within Croatian housing transactions (someone could be a resident of Zagreb and have apartments in Split, and buy flats in Zagreb after the tourist season), we can see that nothing significant happened around the time the housing loan subsidy was introduced, and that this margin does not seem to play an important role.

While all of these analyses serve a way to exhaust possible confounders of our conclusions, and we find that we are not misinterpreting tourism changes in touristic activity as the effect of the subsidy, we nonetheless argue that tourism is an important determinant of the housing market in Croatia. In particular, we argue that tourism puts permanent pressure on the residential market in Croatia. In a Hilber and Turner (2014) framework, which shows that price capitalization of such measures will be present if the housing supply is inelastic, we argue that tourism systematically absorbs dwellings for its use, leaving the residential market tight. In other words, we argue that tourism is a main driver of residential supply inelasticity, causing housing loan subsidy to be capitalized into price increases.

Figure 11: Transactions with domestic and foreign buyers (both apartments and houses)

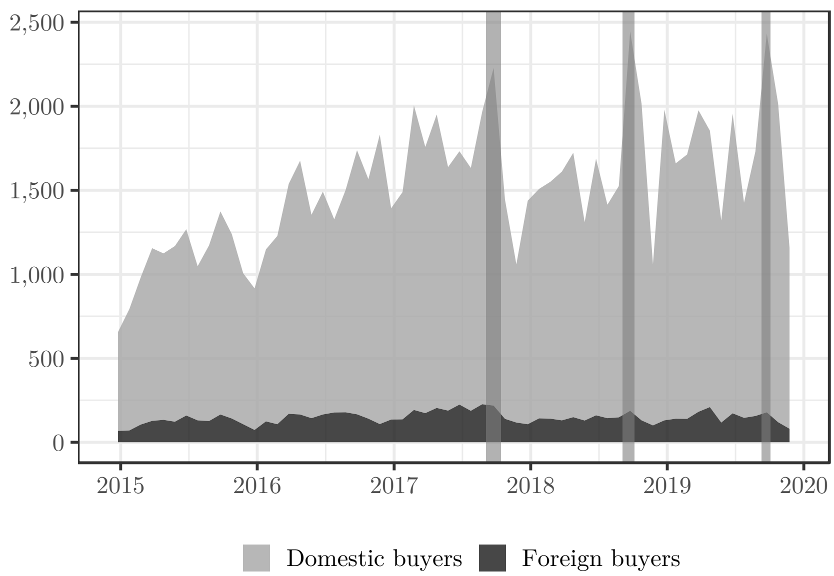
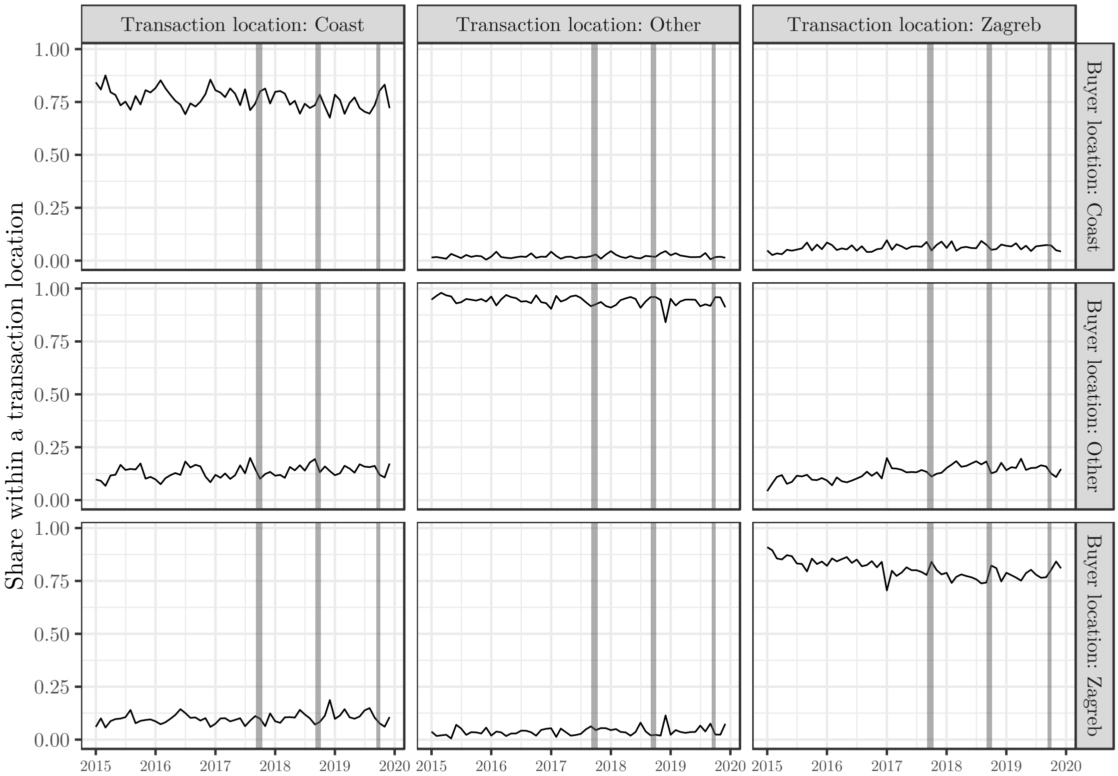


Figure 12: Housing transactions across location of transaction and location of buyer



Note: Each panel represents a share of transactions from different buyer locations (coast, other, and Zagreb, excluding foreign buyers) in the total number of transactions within a location (coast, other, and Zagreb). Therefore, the shares across the columns have to sum up to one. For example, panel (1, 3) shows the dynamics of the share of buyers from coastal municipalities in transactions that take place in Zagreb.

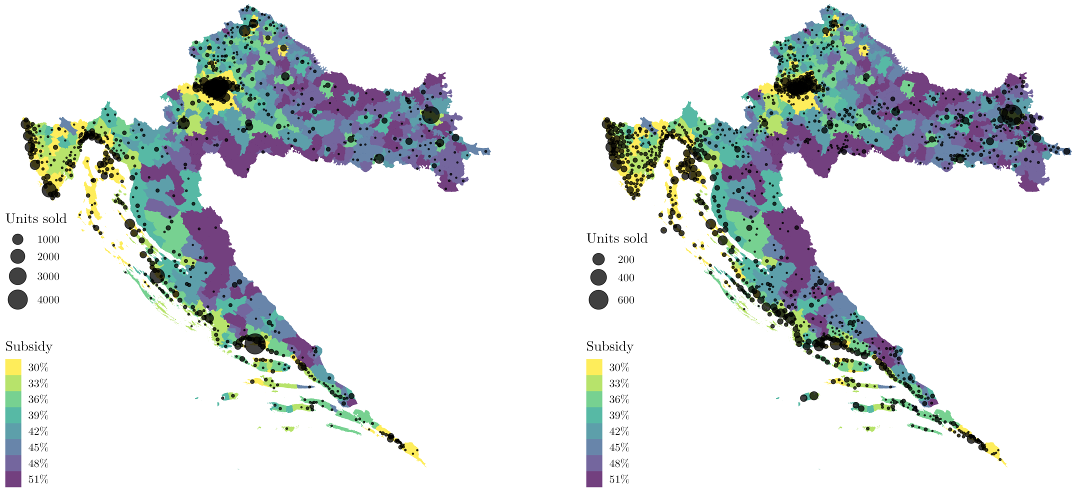
3.4. Geographical discontinuity analysis of housing loan subsidy intensity

The introduction of differential municipality-based annuity coverage in 2018 and 2019 (see Figure 2) enables us to use geographical borders as discontinuities to explore whether different potential subsidy affected housing prices differently. One could approach this question from different empirical perspectives, for example, a simple model including the whole of Croatia where the price dynamics are explained with potential subsidy coverage comes to mind. However, this model would neglect idiosyncratic spatial patterns and its interaction with the real estate market. For example, housing loan subsidy effects in Zagreb and, for example, Lika, might be very different as Zagreb already had a vibrant economic and real estate activity.

Instead, we look only at the subsample of locations to compare transactions around the border where potential housing loan subsidy changes. If the bandwidth around the border is narrow enough, arguably, we are circumventing the problem of spatial patterns and estimating a causal effect. Given that we can assign cadastral municipality to every transaction in the dataset (3,368 of them, see Figure 18 in Appendix), we get a proxy of a transaction location by calculating the centroid of the cadastral municipality. The map of transaction locations on top of potential subsidies is presented in Figure 13. Using these locations, we can find *pairs* of transactions ij, where $i \neq j$, that satisfy three conditions: (i) they were sold in the same month; (ii) they are located within a certain bandwidth, we choose 10 km; (iii) they have different implied housing loan subsidies. The locations that belong to such pairs are presented in Figure 14.

Figure 13: Potential housing loan subsidy in 2018 and 2019 and number of units sold (2015–2019)

(a) Apartments and flats (b) Houses



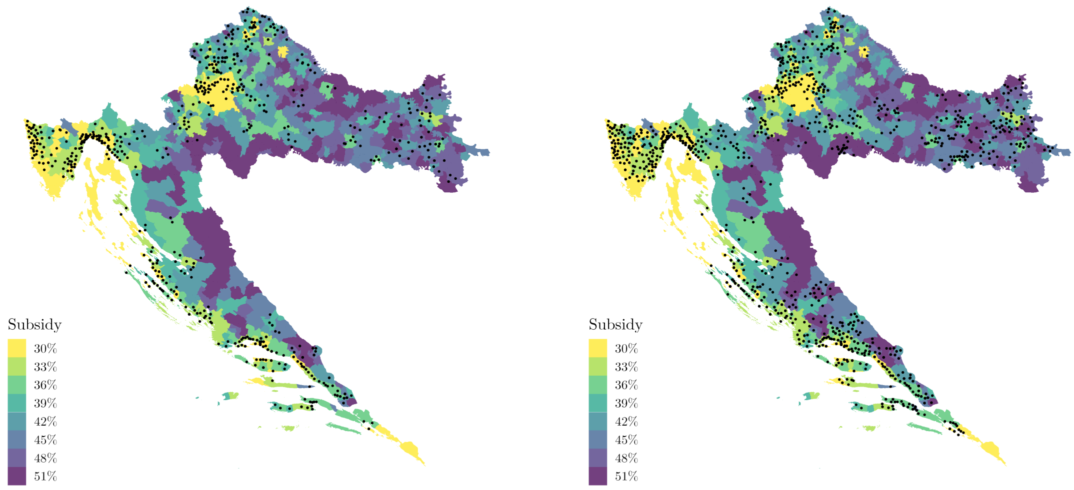
Using bilateral pairs of transactions we inspect if the difference in transaction prices across close locations with different potential subsidies changes over time. In particular, using the datasets of bilateral pairs of transactions ij, we estimate an augmented Equation 1:

$$d(ln(price_i), ln(price_j)) = \sum_{k=1}^{T} \delta_k D_{ik} D_{jk} d(sub_i, sub_j) + \alpha d(\boldsymbol{X}_i, \boldsymbol{X}_j) + \sum_{l=1}^{L} \beta_l loc_{il} + \sum_{m=1}^{L} \gamma_m loc_{jm} + \epsilon_{ij} \quad (3)$$

where $d(\cdot)$ is a standard Euclidean distance measure, so $d(ln(price_i), ln(price_j))$ represents the absolute value of difference of ln prices per square meter of residential unit i and j, $d(sub_i, sub_j)$ is the absolute value of difference in potential subsidies, $d(\boldsymbol{X}_i, \boldsymbol{X}_j)$ represent the distances values between explanatory variables (size, age and condition of the residential unit), while β_l-s and γ_m-s represent the location (municipality) fixed effects. The parameters of interest are δ_k-s which capture the time-specific effect of difference in im-

Figure 14: Locations of borderline sample, 10 km radius

(a) Apartment and flats (b) Houses

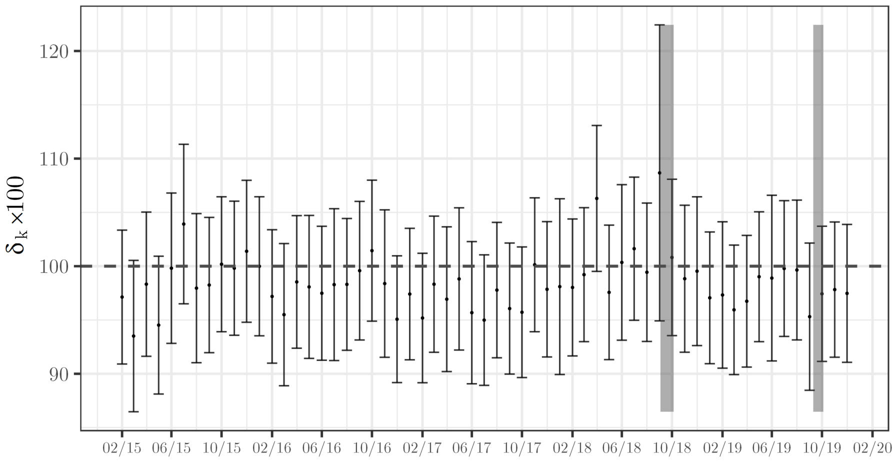


plied subsidy for residential unit i and j on the distance in prices. In a nutshell, we again inspect whether δ_k-s change in a k when the differential subsidy is introduced — October 2018.

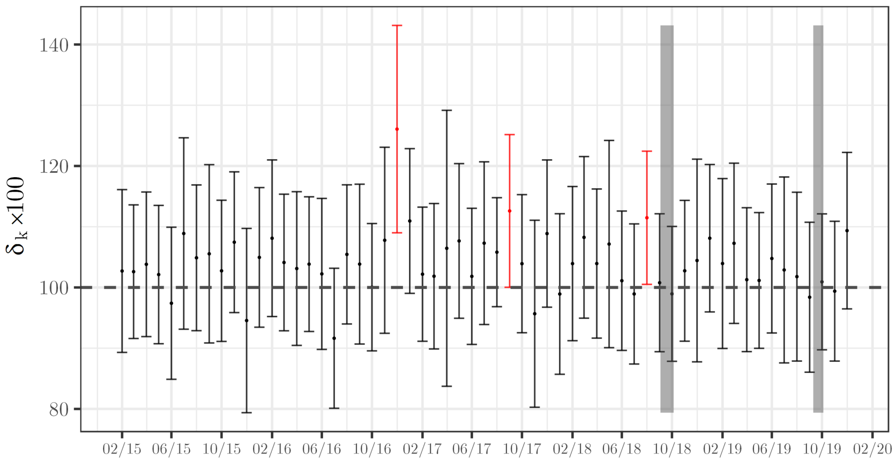
This approach allows us to inspect whether the introduction of a municipality-based potential subsidy in 2018 and 2019 changed this difference and explore whether the intensity of the subsidy affected prices. The time-specific parameter of this difference is presented in Figure 15. As we can see that the difference is stable across time, we can infer that the *intensity* of housing subsidy loan does not affect prices. In other words, while the introduction of the housing loan subsidy did trigger excess demand and contributed to the overall housing price increase, the introduction of different potential housing loan subsidies did not affect prices in less developed regions. The interplay of these results indicates that the housing price increase was recorded in more affluent regions, where the housing market was more active anyways, and that less developed regions did not record any price distortions as the housing market potential was low anyways. This yields an intuitive conclusion, from which a direct policy recommendation can be derived, that a subsidy had a more price distortionary effect in places where the housing market was anyways more active.

Figure 15: Results of the event time study for the border sample (10 km radius)

(a) Apartment and flats



(b) Houses



Note: Figures represent the results from the bilateral pairs of transaction dataset. Dots represent time-specific point estimates next to the difference in the implied potential subsidy (with the reference to January 2015), while bars represent the 99% confidence intervals based on standard errors clustered at the municipal level. Covariates include difference in size between dwellings, difference in year of build and municipality fixed effect for both transactions in a pair. Red bars indicate effects significant at the 99% level.

4. Conclusions

In this paper, we explore whether the housing loan subsidy, introduced in Croatia in 2017, contributed to the overall housing price increases. The subsidy, introduced to make housing more affordable, was designed to cover a portion of annuities in the initial period of the housing loan repayment, with a distinct feature that a household could apply for the subsidy only during a month-long period. This question of the effectiveness of the measure is important because if the subsidies increased housing prices, first-time buyers that are targeted by the subsidy face an ineffective measure, largely offset by price inflation. In addition, increased housing prices imply that the non-users of the measure who are buying homes are also paying these elevated prices, which makes housing less affordable. We offer suggestive empirical evidence that the housing loan subsidy contributed to the overall housing price increases. Our results are robust to different specifications and approaches and withstand the scrutiny of exploring confounder channels. Therefore, contrary to the proclaimed aim of the program, we show that the housing subsidy made housing less affordable, especially for the non-recipients. However, in order to offer a more comprehensive characterization of the program, additional analysis is due. For example, one could enhance the analysis of international housing cycles or explore the effect of tourism on real estate price in more depth, while a detailed data on recipients and non-recipients would grant the analysis of the deadweight loss of the program, as well as the analysis of the demographical and migration aspect and goals of the program.

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6. Appendix

Table 3: Results of the event study analysis

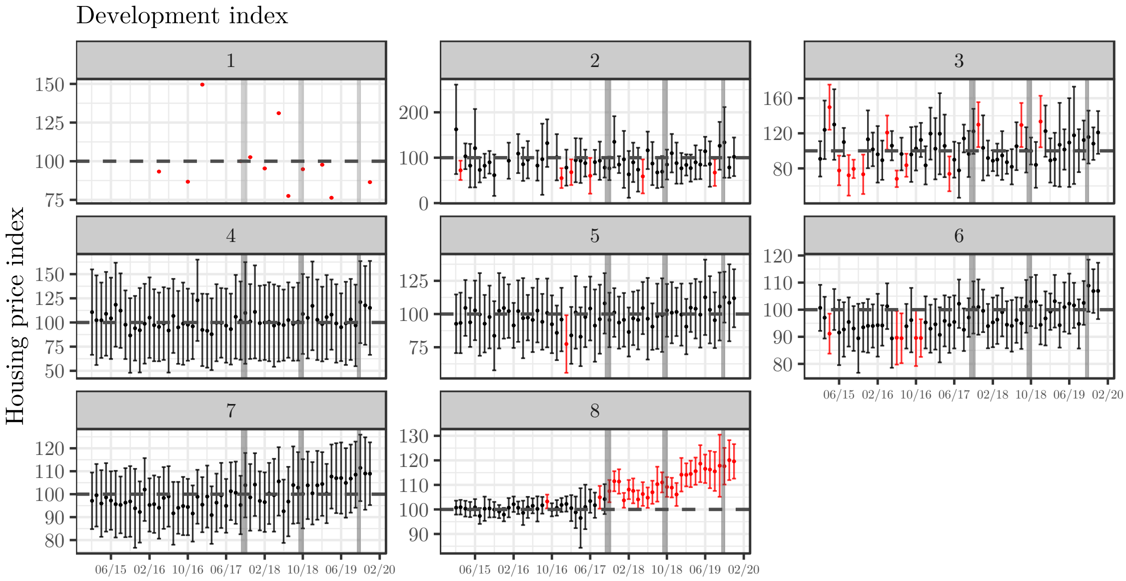
	Flats and apartments		Houses	
	Coefficient	Standard error	Coefficient	Standard error
Time specific effects (with respect to the 2015/01)				
2015/02	0.004	(0.014)	0.090	(0.095)
2015/03	0.0003	(0.015)	0.008	(0.096)
2015/04	−0.009	(0.017)	0.003	(0.100)
2015/05	−0.003	(0.015)	−0.020	(0.098)
2015/06	−0.004	(0.019)	0.078	(0.112)
2015/07	−0.031*	(0.016)	−0.020	(0.094)
2015/08	−0.011	(0.022)	0.026	(0.101)
2015/09	−0.010	(0.017)	−0.019	(0.098)
2015/10	−0.020	(0.016)	0.014	(0.096)
2015/11	−0.025	(0.015)	−0.080	(0.115)
2015/12	−0.030**	(0.014)	0.069	(0.108)
2016/01	0.0002	(0.018)	−0.058	(0.112)
2016/02	0.002	(0.019)	−0.054	(0.097)
2016/03	−0.007	(0.014)	0.141	(0.103)
2016/04	−0.020	(0.023)	−0.035	(0.093)
2016/05	−0.005	(0.022)	−0.022	(0.125)
2016/06	−0.002	(0.016)	−0.068	(0.099)
2016/07	−0.017	(0.027)	0.030	(0.100)
2016/08	−0.006	(0.020)	−0.051	(0.095)
2016/09	0.014	(0.018)	−0.143	(0.108)
2016/10	−0.020	(0.016)	−0.038	(0.107)
2016/11	−0.017	(0.019)	−0.125	(0.109)
2016/12	0.008	(0.014)	−0.002	(0.105)
2017/01	−0.0005	(0.019)	0.014	(0.115)
2017/02	−0.011	(0.026)	0.044	(0.103)
2017/03	−0.031	(0.032)	0.057	(0.095)
2017/04	−0.044	(0.055)	−0.073	(0.113)
2017/05	−0.002	(0.040)	0.006	(0.093)
2017/06	0.014	(0.023)	−0.018	(0.103)
2017/07	0.007	(0.023)	0.062	(0.103)
2017/08	0.030	(0.023)	0.067	(0.103)
2017/09	0.022	(0.030)	0.124	(0.093)
2017/10	0.060***	(0.021)	0.235***	(0.091)
2017/11	0.082***	(0.023)	0.226**	(0.094)
2017/12	0.085***	(0.025)	0.174	(0.108)
2018/01	0.017	(0.018)	0.058	(0.110)
2018/02	0.046*	(0.025)	0.064	(0.099)
2018/03	0.050*	(0.027)	0.085	(0.097)
2018/04	0.024	(0.019)	0.019	(0.102)
2018/05	0.048**	(0.023)	0.165*	(0.098)
2018/06	0.017	(0.025)	0.141	(0.102)
2018/07	0.041	(0.026)	0.143	(0.091)
2018/08	0.071**	(0.034)	0.004	(0.099)
2018/09	0.081***	(0.021)	0.152	(0.093)
2018/10	0.068***	(0.021)	0.124	(0.102)
2018/11	0.070***	(0.019)	0.173*	(0.101)
2018/12	0.048**	(0.022)	0.065	(0.110)
2019/01	0.102***	(0.034)	0.098	(0.096)
2019/02	0.099***	(0.028)	0.122	(0.106)
2019/03	0.102***	(0.031)	0.094	(0.100)
2019/04	0.112***	(0.030)	0.075	(0.100)
2019/05	0.136***	(0.037)	0.131	(0.098)
2019/06	0.125***	(0.030)	0.163	(0.103)
2019/07	0.119***	(0.036)	0.164*	(0.087)
2019/08	0.107***	(0.037)	0.073	(0.095)
2019/09	0.130**	(0.051)	0.092	(0.094)
2019/10	0.147***	(0.029)	0.182**	(0.091)
2019/11	0.157***	(0.035)	0.234**	(0.111)
2019/12	0.156***	(0.030)	0.274**	(0.110)
Ten size dummies	Yes		Yes	
Ten age dummies	Yes		Yes	
Three condition dummies	Yes		Yes	
Foreign buyer and seller dummies	Yes		Yes	
Municipality fixed effects	Yes		Yes	
Observations	79,026		12,078	
Adjusted R^2	0.466		0.500	
Residual Std. Error	0.297		0.703	

Note: Standard errors are clustered at the municipal level.

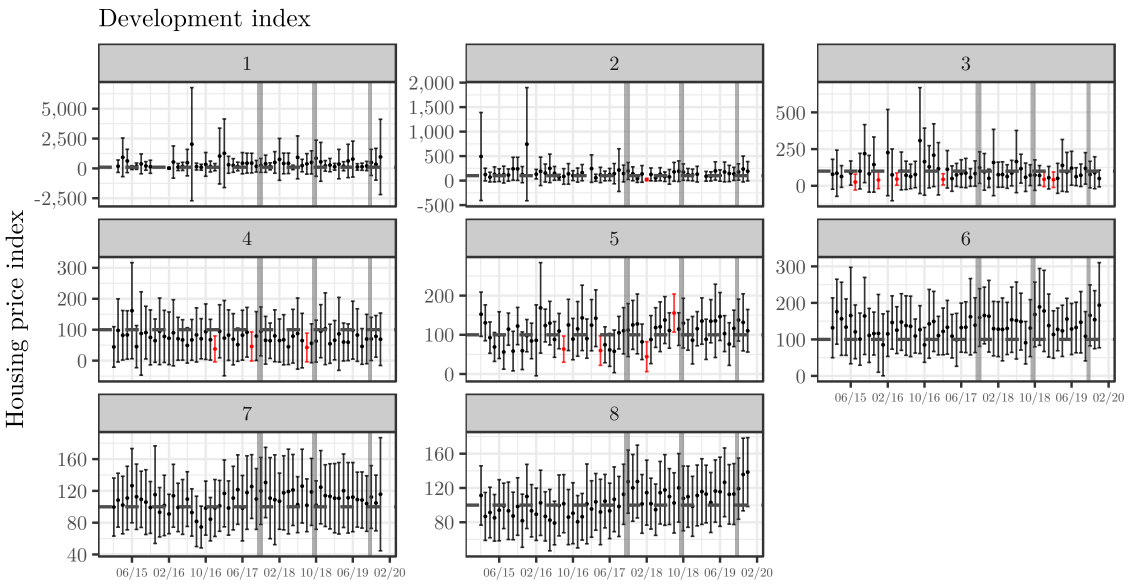
*p<0.1; **p<0.05; ***p<0.01

Figure 16: Development index-based event study

(a) Apartments and flats



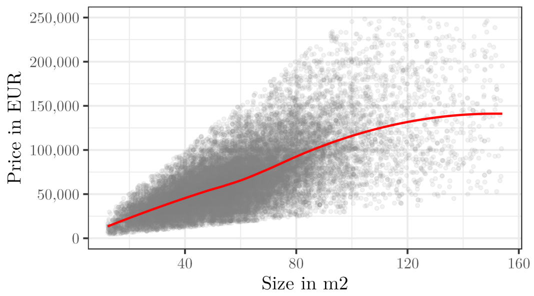
(b) Houses



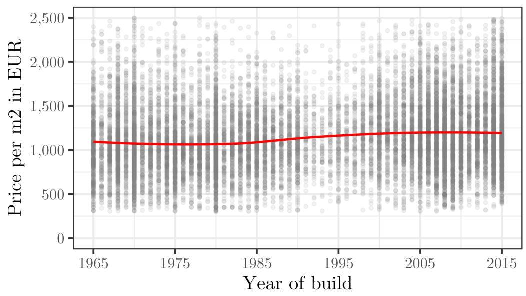
Note: Dots represent time-specific point estimates ($exp(\delta_k) \times 100$; with the reference to January 2015), while bars represent the 99% confidence intervals based on standard errors clustered at the municipal level. Covariates include ten group dummies for size of the dwelling, ten group dummies for the year of build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller, and municipality fixed effect. Red bars indicate effects significant at the 99% level.

Figure 17: Apartment and flats price in 2015 and 2016 descriptives

(a) Size and price gradient



(b) Year of build and price per m2 gradient



Note: Red lines represent local linear regression estimate of y on x.

Figure 18: Cadastral municipalities and potential subsidy in 2018

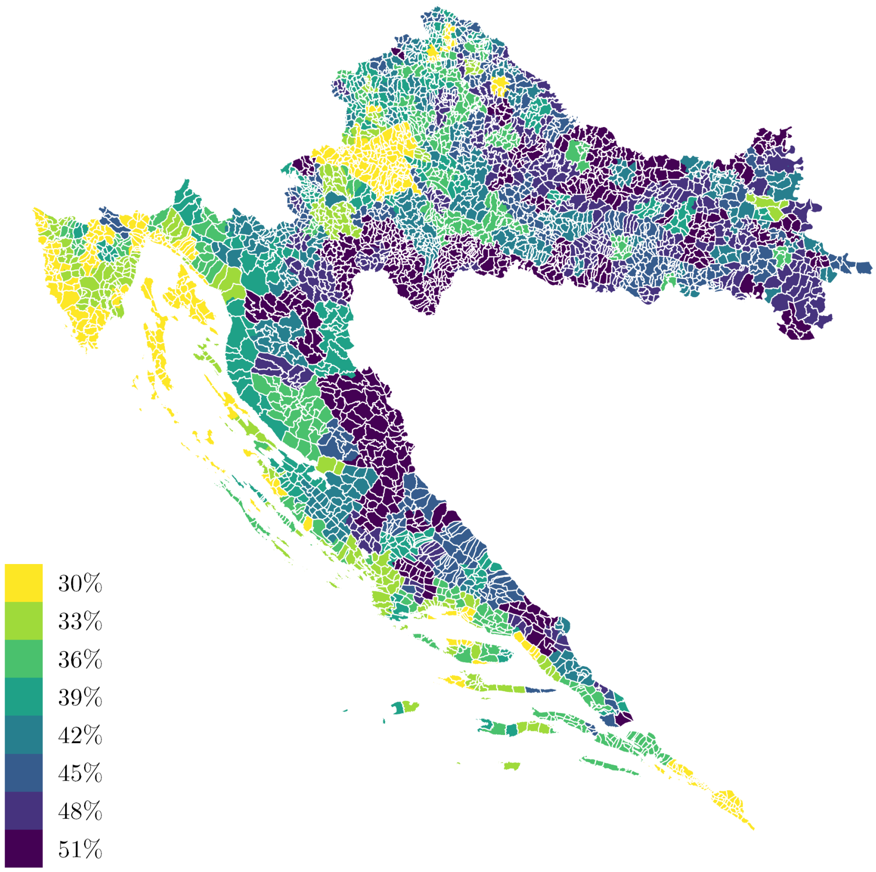


Table 4: Description of estimated models

Estimated model	Data frequency	Independent variables	Sample size	Results in paper
Hedonic regression.	Individual residential transactions data with monthly time dummies.	Ten group dummies for the size of the dwelling, ten group dummies for the year of the build (NA are coded and included), three group dummies for the condition of the dwelling (NA are coded and included), indicators for foreign buyer and seller, and municipality fixed effect.	79,026 for apartments and flats and 12,078 for houses.	Figure 5 and Table 3
Hedonic regression, heterogeneous effects based on the county, size, year of build, and development index.	Individual residential transactions data with monthly time dummies.	Same as in the baseline hedonic regression, albeit omitting the variable on which the grouping was based on.	79,026 for apartments and flats and 12,078 for houses.	Figure 6 (county), Figure 7a (size), Figure 7b (year of build), Figure 16 (development index).
Principal component analysis on housing price cycles at the business and financial frequency.	Quarterly data on housing prices across 20 European countries from 2008 q1 to 2019q4.	-	48 observations for each of the 20 countries.	Figure 8.
Hedonic regression with tourism controls.	Individual residential transactions data with yearly time dummies.	Same as in the baseline hedonic regression with the addition of the annual touristic nights spent per capita for each of the municipality.	78,001 for apartments and flats and 11,656 for houses.	Figure 9 and Table 2.
Hedonic regression on the borderline sample.	Pairs of individual residential transactions that are sold in the same month, are less than 10 km physically apart, and have different implied subsidy based on the development index. Time effects are estimated with the monthly dummies.	Euclidean distance between transactions' ln prices per square meter, potential subsidies, size, ag, condition of the residential unit, and municipality fixed effects for each of the transaction.	33,631 for apartments and flats and 3,374 for houses.	Figure 15

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