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DISCUSSION PAPER

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# The Impact of Heating Efficiency Investment Subsidies on Real Estate Prices: Evidence from Latvia

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## Abstract

A large portion of the Latvian housing stock is aged and, as a result, quite inefficient pertaining to heating energy consumption. Despite government programmes that subsidize investment in these buildings to improve their heating efficiency, only a small portion of this old housing stock has been retrofitted. This study explores the economic dimension as a possible factor contributing to the low interest in carrying out such renovations. Specifically, the return on investment in retrofitting buildings is analysed by looking at the differences in prices of otherwise similar apartments in renovated and non-renovated buildings. Combining data on renovation projects in Latvia, which were completed in part utilizing EU funds between 2016 and 2023, with the Real Estate Transactions database, containing all property transactions in Latvia, and data from Latvia's Credit Registry, the study shows that apartments in retrofitted buildings cost roughly 11% more than otherwise similar apartments in non-retrofitted buildings. Taking into account the costs and savings related to these renovations already incurred by the sellers, the premium amounts to 10% of an apartment's value. The impact varies across regions, increasing with the quality of the renovation, and is highly contingent on government subsidies.

**Keywords:** Heating Efficiency Renovations, Housing Market, Net Present Value, Hedonic Regression

**JEL Codes:** Q56, R32, P18

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**Disclaimer:** The views expressed herein are solely those of the authors and do not necessarily reflect the views of Latvijas Banka.

# 1 Introduction

Latvia is one of three Baltic countries located in the northern part of Europe. This region has three characteristics which make the analysis of heating efficiency renovations particularly relevant: cold weather, energy dependence, and a legacy Soviet era housing stock that is highly energy inefficient.

Since the region is in the north, the weather is quite cold. According to the [World Bank \(nd\)](#), even though Climate Change has brought about a 1 degree Celsius increase in Latvia's average monthly temperature, it is still below 18 degrees throughout the year on average and, in winter, usually dipping below 0 degrees Celsius. The [World Health Organization \(2018\)](#) defines 18 degrees Celsius as the minimum air temperature within the range of healthy living conditions. For this reason, heating and thermal insulation are necessities for housing units in Latvia<sup>1</sup>.

Another feature of Baltic countries is the fact that they are post-Soviet states, where, during Soviet times, to address the housing shortage, mass housing projects were completed. Prefabricated standardized residential apartment buildings were built following the 1957 Union-wide competition for cost-effective design and construction ([Meuser 2024](#)). To this day, more than half of the population of Latvia lives in these buildings ([Central Statistical Bureau of Latvia 2023b](#)), despite them being quite aged and, by today's standards, energy inefficient ([Cabinet of Ministers 2020](#)).

This inefficiency results in high heating energy needs which are primarily met by burning wood chips and natural gas. Latvia has been gradually substituting its imported gas consumption with domestically grown wood over the past decade. However, the former still covers approximately 40% of all heating energy used (see Figure 1). This is nearing the threshold in which it would be difficult to substitute gas consumption, as about 80%<sup>2</sup> of the remaining gas is used by combined heat and power plants (CHPP-1 & CHPP-2). As a result, Latvia will continue to be partially dependent on imports for its energy needs. Dependence on natural gas poses a problem as it is roughly three times more expensive than wood, costing 71 eur/MWh ([Eurostat 2025](#)) compared to 25 eur/MWh ([Baltpool nd](#)) respectively at the end of 2024. The price difference increases the weight of natural gas in the basket of energy sources used for apartment heating purposes to about 50%.

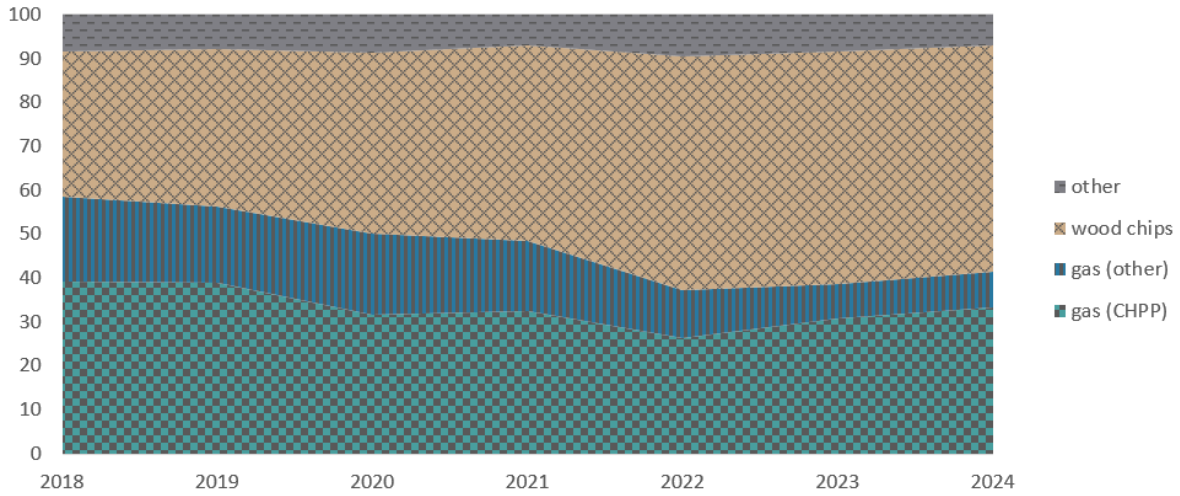
An alternative to using large amounts of energy to heat old apartments is to conduct heating efficiency renovations, which decrease the amount of required heating by reducing the rate at which

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<sup>1</sup>Both are essential but also act as substitutes for each other. Residents of buildings with poor insulation can compensate for this by spending more energy on heating, and vice versa.

<sup>2</sup>Calculated by dividing the amount of gas Latvenergo consumed in 2024 ([Latvenergo \(2024\)](#)) by total gas consumption in 2024 in Latvia ([Central Statistical Bureau of Latvia 2025c](#)).

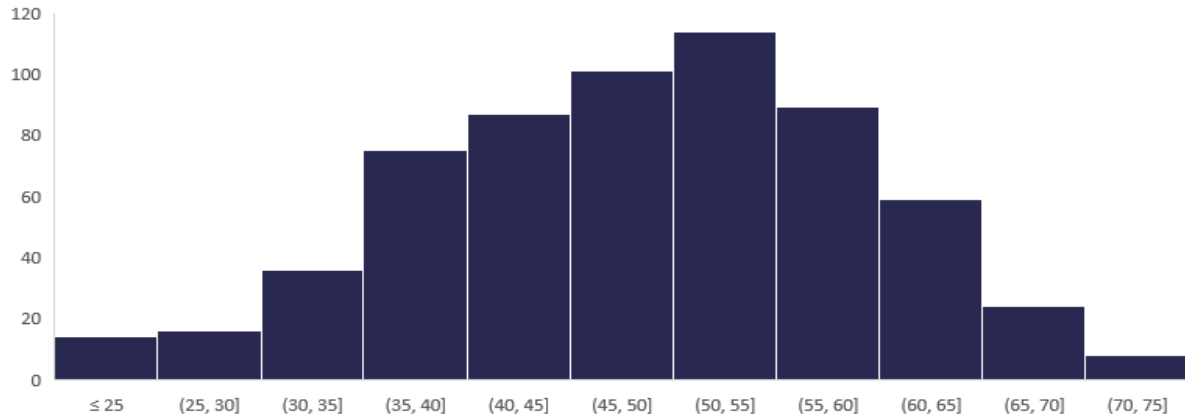
**Figure 1:** Apartment heating energy source weight by MWh spent in Latvia % over time



Source: [Central Statistical Bureau of Latvia \(2025d\)](#), [Central Statistical Bureau of Latvia \(2025b\)](#), [Latvenergo \(2024\)](#).  
Notes: Gas (CHPP) shows the share of heating energy consumed which is produced by Latvenergo's 2 combined heat and power plants.

heat escapes buildings. Renovations which have been completed thus far show a significant boost to heating efficiency, averaging at around 50% (see Figure 2). Nevertheless, up until the end of 2023,

**Figure 2:** Count of apartment buildings retrofitted by efficiency gain



Source: [ALTUM \(2025\)](#).

only about 5%<sup>3</sup> of apartment buildings, which had been built prior to 2000, have seen noticeable upgrades in terms of their heating efficiency.

The low uptake of renovations, despite their proven effectiveness, raises a question – why do so few apartment buildings undergo renovations? [Asmare et al. \(2023\)](#) conducted an analysis of 1041 respondents' answers to a survey on financial literacy and the willingness to conduct renovations

<sup>3</sup>Calculated by taking the share of renovated pre-2000 built apartment buildings ([Central Statistical Bureau of Latvia 2022](#)); and adding the number of renovated buildings between 2021 and 2023 ([ALTUM 2025](#)) divided by the total number of pre-2000 built apartment buildings ([Central Statistical Bureau of Latvia 2023b](#)).

on their Soviet-era apartments in Lithuania. While they tested 17 possible drivers of willingness to renovate, only a few were significant, most notably - trust in institutions as well as financial and energy-cost literacy. The latter finding shows that people better equipped to make financial decisions give greater value to renovations.

[Jakučionyte and Singh \(2024\)](#) employed the repeated sales hedonic model over the period 2010-2023 on 30,339 Soviet-era built Lithuanian apartments, 1756 of which were renovated between the sale dates. Their findings showed that retrofitting increased the value of the underlying apartments by approximately 8%. However, when estimating whether such renovations had been profitable for the owner, results were negative due to renovation costs exceeding the market premium of this type of renovation. Their estimates, based on an assumption that the entirety of the renovation cost is paid prior to the sale, showed that people who opted to retrofit their homes experienced a loss amounting to more than 20% of their apartment value.

This study analyzes the effect of heating efficiency renovations on real estate prices in Latvia. We study both (1) the increase in the market value of the apartment post renovation and (2) the return on renovations for the owner. This is possible due to having access to very granular information on loans used to finance such renovations, apartments which had been sold, and the renovations themselves, coming from the Credit Registry of Latvia, [The State Land Service \(2025\)](#), and [ALTUM \(2025\)](#) respectively. In addition, we also take into account the heating bill savings gained by the seller of the apartment, accumulated as a result of the renovations.

In a broader context, this study contributes to the existing body of literature related to the return on heating renovations by working with a large sample of renovated apartments, allowing for an econometric analysis. In contrast, previous studies have mostly relied on a small number of observations, calculating the Net Present Value of renovations based on energy efficiency gains, renovation costs, and assumptions regarding future energy prices ([Knuutila et al. 2022](#), [Sundling et al. 2019](#), [Simson et al. 2016](#)), ignoring the additional value coming from renovations which is not observable in heating expenditure, but could be estimated through market prices. Some studies use large enough samples for econometric analysis but stop at the market value difference between retrofitted and non-retrofitted apartments ([Fuerst et al. 2016](#), [Jensen et al. 2016](#)). A drawback of this approach is the fact that the results cannot be interpreted as returns, since the seller may have already paid off some of the renovation cost. Similarly, the results cannot be interpreted as revenue from undertaking renovations, since the seller may not have paid off all the renovation

costs. This study combines NPV accounting exercise with the econometric analysis of housing market renovations' premium to obtain the return.

This study finds that apartments in renovated buildings cost roughly 11% more than otherwise similar apartments in non-renovated buildings. Taking into account the costs and savings related to renovations already incurred by the sellers, the premium amounts to 10% of the property value. The impact varies across regions, increases with the quality of the renovation, and is highly contingent on government subsidies.

The study is structured as follows. The next section describes the data sources used and the way they were combined. Section 3 explains the methodology used to estimate the renovation market premium and the pre-sale saving and cost accounting. This is followed by the results in section 4 and a discussion in section 5. Section 6 concludes the research.

## 2 Data and stylized facts

### 2.1 ALTUM renovations data

ALTUM is a Latvian state-owned development company. One of the activities that ALTUM is engaged in is the redistribution of EU funds, part of which goes towards the improvement of energy efficiency in the residential sector ([ALTUM nd](#)). Since 2016, there have been three iterations of the energy efficiency renovation programme: the 2016-2023 programme allocating 157 million euros, the 2022-2026 programme allocating 57 million, and the 2021-2027 programme allocating 173 million euros of EU funds ([ALTUM 2025](#)). We use data exclusively from the first ALTUM programme as it is the only one for which the renovation quality assessment period has concluded, and all necessary data is available.

This programme had a first-come, first-serve system, where, if all funds had not already been allocated, apartment building representatives could send in an application for an energy efficiency renovation. If the application details met certain criteria, mainly more than half of the apartment owners in the building agreed to have this building renovated and the renovation potential was at least a 30% gain in heating energy efficiency, half of the renovation costs would be covered by a grant from ALTUM. In return, annual heating energy consumption data had to be reported for two years after the renovation was completed. This data, in addition to various other variables, were summarized by ALTUM at the apartment building level and reported once the two-year quality

assessment period of the renovation for all buildings in the programme concluded.

This dataset represents 623 apartment buildings that were renovated between 2016 and 2023, which amount to 22,710 apartments. These apartments experienced a noticeable decrease in heating energy consumption thanks to these renovations as shown in Figure 2. Additionally, the majority of the apartment buildings renovated are those built during the Soviet mass construction era, the focus of this study. When it comes to regional differences in renovation work, only 1.5%<sup>4</sup> of Soviet era apartment units in Riga were renovated through the ALTUM 2016-2023 programme. Other regions were able to increase the share of renovated apartments to a greater extent, most notably Liepāja, renovating 16% of Soviet era apartment units through the same programme.

## 2.2 Real Estate Transaction data

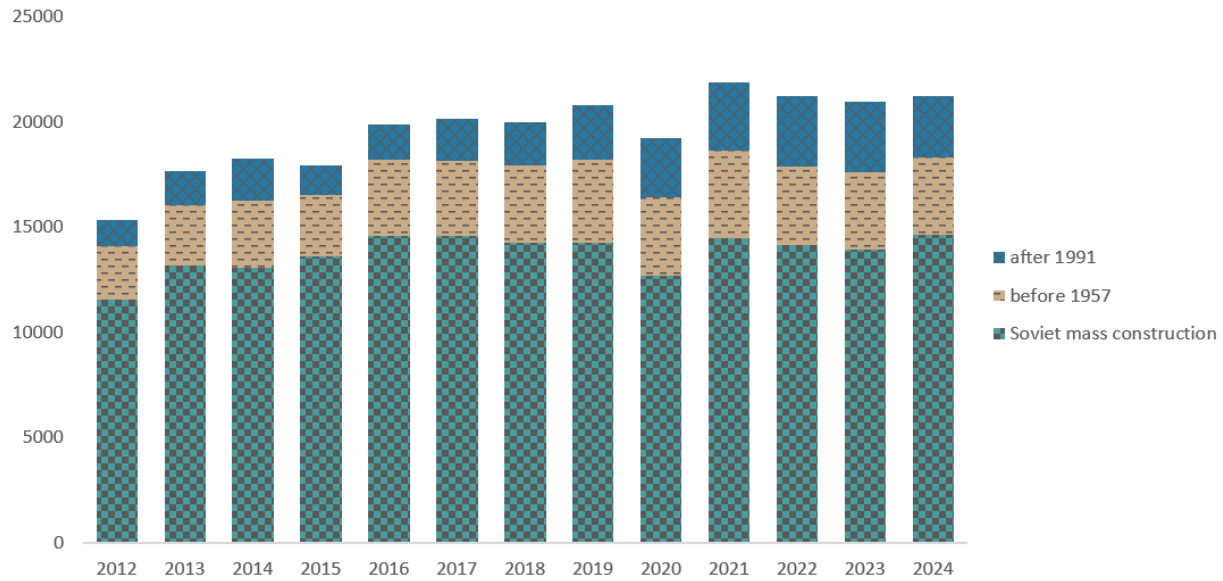
We merge the ALTUM data with the Real Estate Transaction data, which is published monthly by The State Land Service of Latvia. It contains information on transactions including land, buildings, and apartments located in Latvia. Three important pieces of information for our analysis come from this dataset: the construction dates of apartment buildings, the locations of apartments sold, and the prices of these units.

The majority of Latvia’s population lives in Soviet era buildings, consequently apartments located in these buildings represent most transactions in the apartment market (see Figure 3). One third of the population of Latvia lives in Riga ([Central Statistical Bureau of Latvia 2025e](#)), yet the capital accounts for about half of all apartment transactions in Latvia. Soviet-era apartments have generally been relatively inexpensive, both compared to newly built apartments and to those built prior to the mass housing programme (see Figure 4). This is reflective of the fact that Soviet-era apartments were built during a shortage of residential units and held cost-effectiveness and speed of construction at the forefront rather than quality, as outlined by [Meuser \(2024\)](#). However, low prices might also appear due to underreporting the transaction value. For this reason, true real estate prices may be higher. We take this fact into consideration utilizing mortgage data (see Equation 7 in section Methodology).

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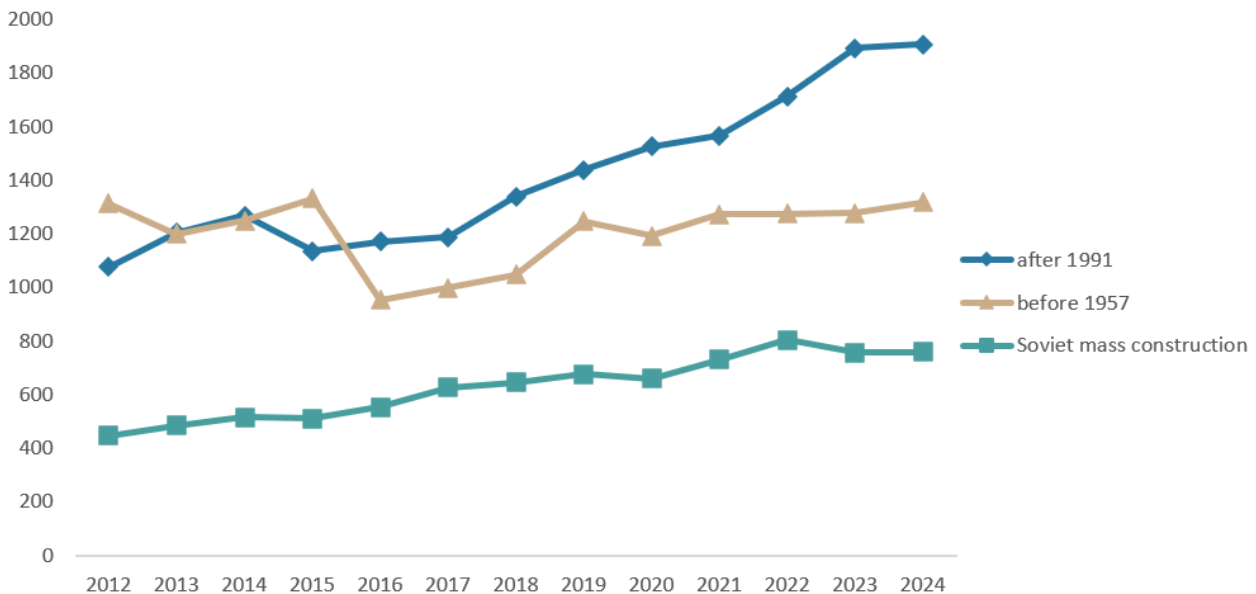
<sup>4</sup>Calculated by dividing the amount of apartment units in the respective city from [ALTUM 2025](#) by the number of 1946-2000 built apartment units in the respective city from [Central Statistical Bureau of Latvia 2023a](#)

**Figure 3:** Count of transactions with apartments over time by construction period



Source: [The State Land Service \(2025\)](#).

**Figure 4:** Average price of apartments EUR per square metre over time by construction period



Source: [The State Land Service \(2025\)](#).

Notes: Only transactions equal to 10,000 EUR and above are considered.

## 2.3 Credit Registry data

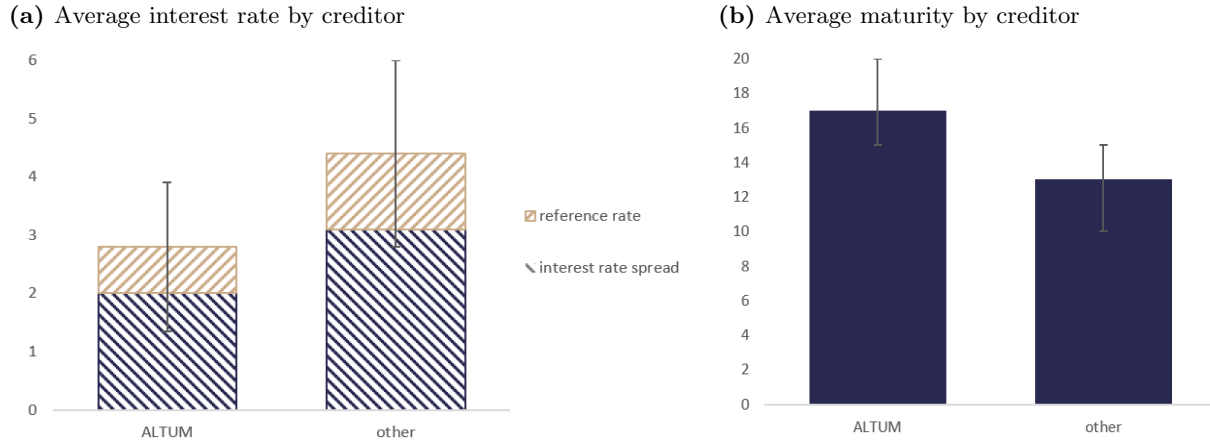
The Credit Registry of Latvia contains all loans given out by Latvia based credit institutions, commercial companies closely related to these credit institutions, credit unions, insurers, financial development institutions, and the treasury, totalling 79 institutions ([Latvijas Banka 2025](#)).



Information on loans for the purpose of retrofitting is found through combining the registry with the renovations data from ALTUM<sup>5</sup>. Out of 623 renovation projects in the programme, 419 were found to have a loan. However, we cannot say with confidence that the other 214 projects were paid for without any financing. It is possible that a portion of the loans were not captured in the dataset. For this reason, these projects are not considered.

ALTUM gave out 152 renovation loans themselves. This financing avenue was available to apartment owners who had been denied a loan by commercial banks. ALTUM offered preferable conditions when it came to the interest rate and maturity (see Figure 5). The one disadvantage was

**Figure 5:** Renovation loan terms at the time of loan inception



Source: Credit Registry of Latvia; Ministry of Economics of the Republic of Latvia (2016).  
Notes: Eight loans which had fixed interest rates are not represented in (a); reference rate is Euribor; Interest rate spread is the rate the bank charges on top of Euribor; in the left hand side graph error bars encapsulate the 25th to 75th percentile of total (reference + spread) interest rates; in the right hand side graph error bars encapsulate the 25th to 75th percentile of maturities.

the fact that if the renovation was financed by ALTUM, the amount given by them as a grant was reduced from 50% to 35% (Ministry of Economics of the Republic of Latvia 2016). This reduction, however, was rolled back at the end of 2018, up to which point only 10 loans were given out by ALTUM.

Only 8 loans in the sample were issued with a fixed interest rate. The rest were issued with a variable interest rate using Euribor as the reference rate. This structure of interest rates is the most common in Latvia and other Baltic countries (Bērziņa et al. 2025).

<sup>5</sup>For information on the identification of loan purpose see Appendix A.1.

## 2.4 Mapping

To analyse the effect that retrofitting has on the price of apartments, these apartments first had to be identified. This entailed a two-step process. First the ALTUM data was mapped to the cadastral data which [The State Land Service of Latvia \(2021\)](#) publishes to obtain cadastre numbers. The cadastre information was added to the ALTUM data using the addresses of buildings, which both data sources have. Second, ALTUM data was joined with the NITIS database by cadastre numbers, attributing the same renovation characteristics to all apartments within the renovated building. To see the costs incurred by the owners choosing to renovate prior to selling their apartment, Credit Registry data was added. The mapping of the Credit Registry was done directly to the ALTUM data. For a more detailed description of data matching procedure, see Appendix [A.1](#).

## 2.5 Filtering

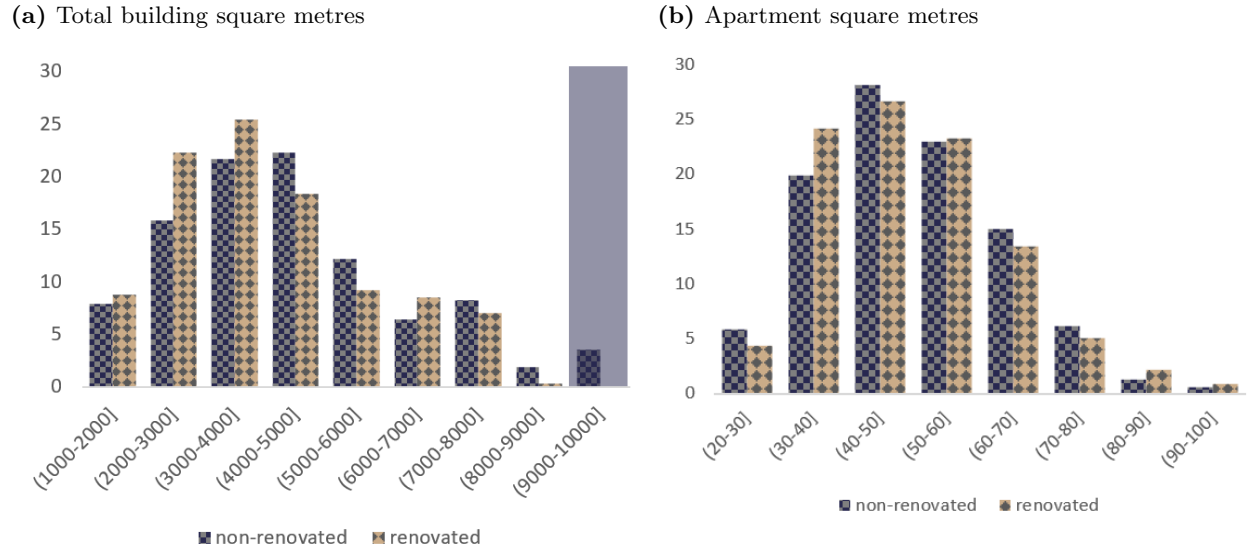
We limit our sample in several ways. First, we include only buildings built between 1957 and 1991, where the apartment building gross floor area is between 1,000 and 10,000 square metres and the apartment area is between 20 and 100 square metres, and the building has at least two floors, all of which are characteristics of Soviet-era apartments. Second, filters to eliminate outliers are applied: the apartment itself has only one floor; it is not a lower ground floor apartment; the price of the apartment ranges between 10,000 and 100,000 EUR, and between 250 and 1,500 EUR per square metre. Lastly, only transactions which happened after 2017 are considered, since 2018 is the first year when a transaction with a renovated apartment occurred.

Transactions with an apartment in a renovated building are defined as those where the transaction date exceeds the renovation completion date, and the heating efficiency gain from the renovation is at least 30%. To ensure that transactions with renovated buildings do not appear in the control group, we first filter out buildings which had been renovated through the ALTUM programme. Secondly, we filter out buildings which have multiple construction completion dates registered, as construction completion dates are added if a building receives a renovation.

To ensure similarity between the control group and the treatment group, additional filtering is performed. This process entails plotting the relative frequency histograms of housing characteristics split by group type, and dropping any observations from the sample where no overlap of the treatment and control group is found. This is done for building level and apartment level characteristics (see Figures [6,7,8](#)). The final dataset consists of 529 transactions with apartments located in

renovated buildings and 38,755 transactions with comparable apartments located in non-renovated buildings.

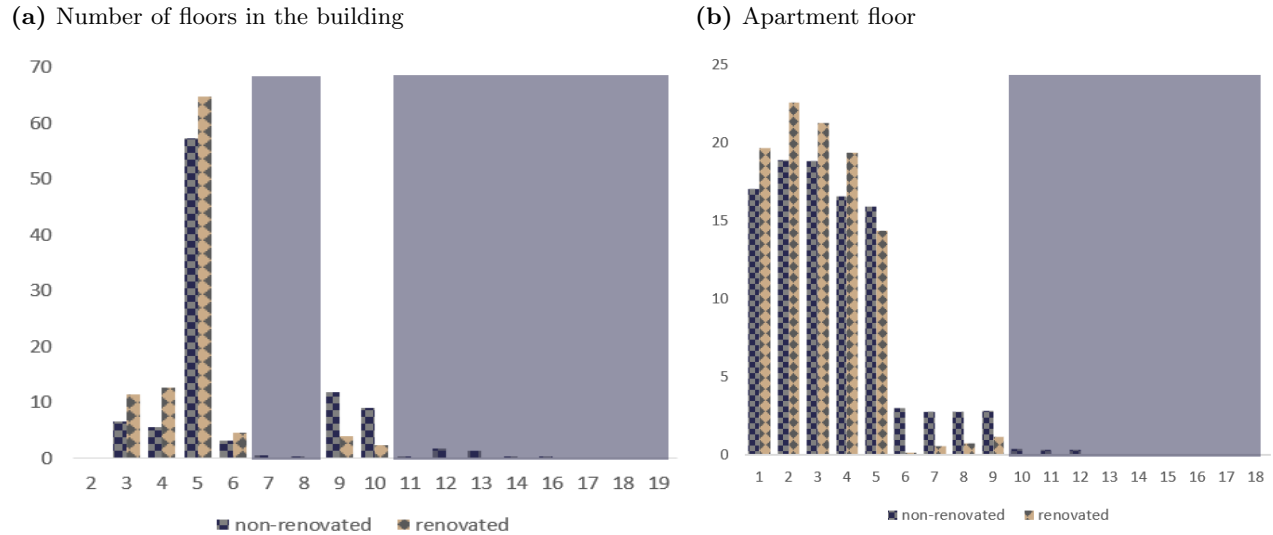
**Figure 6:** Control and treatment group relative frequency histograms by area characteristics



Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

Notes: The shaded area is dropped from the dataset due to 0 overlap of treatment and control group observations.

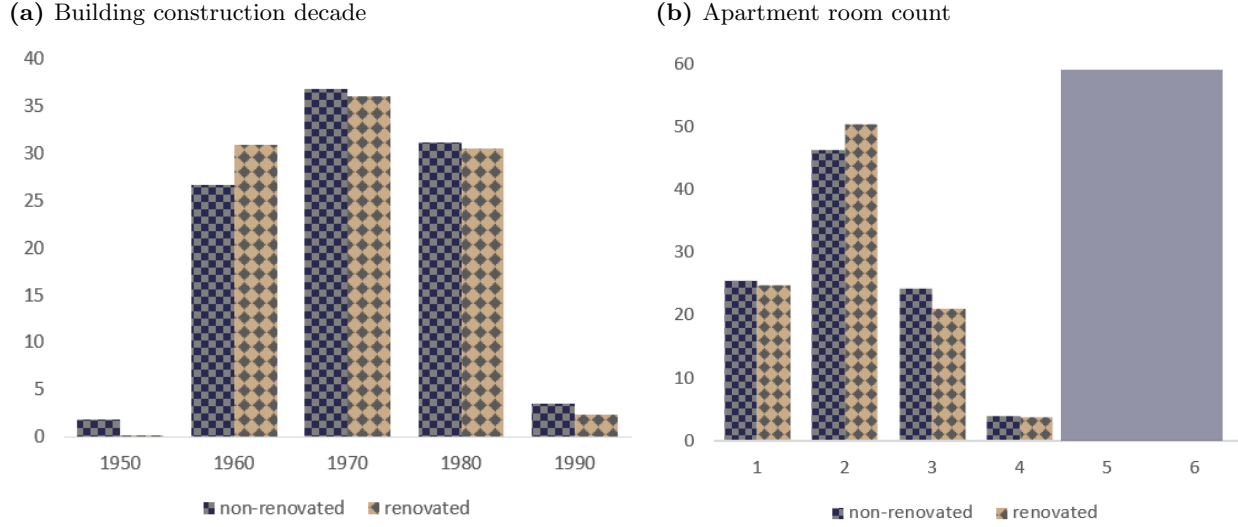
**Figure 7:** Control and treatment group relative frequency histograms by floor characteristics



Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

Notes: The shaded area is dropped from the dataset due to 0 overlap of treatment and control group observations.

**Figure 8:** Control and treatment group relative frequency histograms by construction date and room count



Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

Notes: The shaded area is dropped from the dataset due to 0 overlap of treatment and control group observations.

### 3 Methodology

The methodology consists of two parts. An econometric part for the estimation of the housing market valuation of renovations, and an accounting part, necessary to take into account the costs and savings accumulated due to renovations prior to the sale. The combination of both allows for the estimation of the return on investment in renovations through the government programme, from the perspective of apartment owners. In addition, the return which would have occurred if no government financing were made available is estimated, subject to certain assumptions.

The accounting part is a simple present value calculation of positive cash flows net negative cash flows incurred due to renovating, up to the point of the sale of the apartment. The obtained value represents the fair valuation of the asset, conditional on the fact that all cash flows would stop at the point of sale. The positive cash flows are the savings on heating utility bills. The negative cash flows are the loan payments made for the renovation (Equation 1).

$$NPV_i = (Q_i^{pre} - Q_i^{post}) \cdot \sum_{j=1}^m T_{i,j} \cdot \left(1 + \frac{rfr_j}{12 \cdot 100}\right)^j - \sum_{k=1}^n (P_{i,k} - P_{i,k+1} + P_{i,k} \cdot \frac{r_{i,k}}{12 \cdot 100}) \cdot \left(1 + \frac{rfr_k}{12 \cdot 100}\right)^k \quad (1)$$

where  $NPV_i$  is the net present value of cash flows incurred prior to the sale of apartment  $i$ .  $Q_i^{pre}$

represents the heating energy consumption  $kWh/m^2$  per month for apartment  $i$  before it was renovated,  $Q_i^{post}$  represents consumption post renovation.  $T_{i,j}$  is the heating energy tariff ( $EUR/kWh$ ) for apartment  $i$ ,  $j$  months prior to its sale.  $rfr_j$  is the Latvian Government 10-Year Bond Yield (%),  $j$  months prior to the sale.  $m$  is the time between the end of the renovation work and the sale of apartment  $i$ , measured in months.  $P_{i,k}$  is the remaining loan principal  $EUR/m^2$ , and  $r_{i,k}$  is the interest rate (%) paid on this principal,  $k$  months prior to the sale of apartment  $i$ .  $n$  is the time between loan origination and the sale of apartment  $i$ , measured in months. Note that here we are not discounting the cash flows to the first date of the investment in renovations. On the contrary we are 'accounting' the cash flows to reflect the value at the date of the sale of the apartment. This is done to match the time value of money to the cash flow obtained from the sale of the apartment.

The econometric part is necessary to obtain the housing market valuation of renovations. This is based on the hedonic approach also used in [Jakučionyte and Singh \(2024\)](#). We adapt this methodology to the housing market of Latvia. Using simple OLS, we estimate the price difference between retrofitted and non-retrofitted apartments that are otherwise similar. The similarity is ensured by selecting only Soviet-era apartments which have a standardized design ([Meuser 2024](#)); filtering out transactions based on observed characteristics which are not seen in both the control and treatment group (see Figure 6 and 8); and adding characteristics which may influence the price of apartments to our regression equation (see Equation 2).

$$\ln(y_i) = \beta_0 + \theta r_i + \sum_{j=1}^7 \beta_j factor(X_{j,i}) + \epsilon_i \quad (2)$$

where  $y_i$  represents the price  $EUR/m^2$  of apartment  $i$ , and the coefficient of interest is  $\theta$ , which tells us how much more expensive a retrofitted apartment ( $r = 1$ ) is, compared to a non-retrofitted one ( $r = 0$ ), all else being equal. To reduce the possibility of a biased  $\theta$  estimate, 7 control variables  $X_{j,i}$  are employed: number of rooms in the apartment, apartment floor; number of floors in the building and end of building construction year, which help identify the subtype of Soviet-era apartment; postal code, which controls for the neighbourhood; transaction year and quarter, controlling for general appreciation and seasonality in the housing market. These variables are added as factors rather than continuous variables, as their effects can be non-linear.

In addition to the baseline regression described above, we look at 5 further specifications. One where instead of considering all renovations to be equal, the efficiency gain from the renovation is

split into bins: 30%-45%, 45%-60%, 60% and above (see Equation 3).

$$\ln(y_i) = \beta_0 + \theta_1 r_i^{30-45} + \theta_2 r_i^{45-60} + \theta_3 r_i^{60+} + \sum_{j=1}^7 \beta_j factor(X_{j,i}) + \epsilon_i \quad (3)$$

We also investigate whether the impact of renovations became stronger after the recent spike in energy prices following Russia's invasion of Ukraine. We do that by interacting the renovation dummy with a time dummy that takes the value of 1 if the apartment sale date is between 2021 and 2024 (see Equation 4).

$$\ln(y_i) = \beta_0 + \theta_1 r_i + \theta_2 r_i s_i^{2021+} + \sum_{j=1}^7 \beta_j factor(X_{j,i}) + \epsilon_i \quad (4)$$

We further examine whether the impact of renovations changed due to an increase in construction prices following the invasion. This is done by interacting the renovation dummy with a time dummy that takes the value of 1 if the renovation began between 2021 and 2024 (see Equation 5).

$$\ln(y_i) = \beta_0 + \theta_1 r_i + \theta_2 r_i b_i^{2021+} + \sum_{j=1}^7 \beta_j factor(X_{j,i}) + \epsilon_i \quad (5)$$

We also explore whether the disproportionate uptake of renovations in Riga and Liepāja is driven by different returns in these regions. For this, we introduce two interaction terms. One where the renovation dummy is interacted with a location dummy which takes the value of 1 if the apartment is in Riga. Another where the renovation dummy is interacted with a location dummy which takes the value of 1 if the apartment is in Liepāja (see Equation 6).

$$\ln(y_i) = \beta_0 + \theta_1 r_i + \theta_2 r_i l_i^{Riga} + \theta_3 r_i l_i^{Liepaja} + \sum_{j=1}^7 \beta_j factor(X_{j,i}) + \epsilon_i \quad (6)$$

Lastly, due to the substantial size of Latvia's informal economy, the potential effect of tax evasion is considered. This is done by interacting the renovation dummy with a mortgage dummy which takes the value of 1 if the purchase of the apartment was financed with a mortgage. (see Equation 7). A mortgage works as an indicator that the reported value of the transaction is correct, since

banks giving out these loans must validate the sale price.

$$\ln(y_i) = \beta_0 + \theta_1 r_i + \theta_2 r_i m_i + \sum_{j=1}^7 \beta_j \text{factor}(X_{j,i}) + \beta_8 m_i + \epsilon_i \quad (7)$$

All the regression specifications seen above estimate the housing market value of retrofitting. However, the interpretation is muddled by loans taken out to finance these renovations.  $\theta$  cannot be interpreted as a return on investment in renovations, since the seller may have already paid off some of the renovation loan. Neither can it be interpreted as revenue from undertaking renovations, since the seller might not have paid off all the renovation loan. To amend this, the NPVs calculated in the accounting part of the methodology (see Equation 1) are added to the apartment prices in the aforementioned regression equations. The baseline regression with an adjustment is shown in Equation 8.

$$\ln(y_i + NPV_i) = \beta_0 + \theta r_i + \sum_{j=1}^7 \beta_j \text{factor}(X_{j,i}) + \epsilon_i \quad (8)$$

The above mentioned modification allows for the quantification of returns on investments in renovations through the government programme. However, it is important to recall that these renovations were heavily subsidized (see Section 2.1). For this reason, we introduce an additional adjustment to estimate the returns on investments in renovations without the government subsidy. This is done by subtracting the granted amount  $G_i$  ( $EUR/m^2$ ) from the  $NPV_i$  calculated in the accounting part, also accounting for the time value of money (see Equation 9). After which  $NPV_i^{scenario}$  enters regressions the same way as  $NPV_i$  does in Equation 8.

$$NPV_i^{scenario} = NPV_i - G_i \cdot \left(1 + \frac{rfr_k}{12 \cdot 100}\right)^k \quad (9)$$

## 4 Results

The estimated returns on investments in renovations are summarized in Table 1.

**Table 1:** Results with loan payment adjustment

|                                  | (1)                 | (2)                 | (3)                 | (4)                 | (5)                 | (6)                 |
|----------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Renovation                       | 0.099***<br>(0.014) |                     | 0.023<br>(0.033)    | 0.102***<br>(0.015) | 0.115***<br>(0.017) | 0.102***<br>(0.016) |
| Renovation efficiency 30-45%     |                     | 0.063***<br>(0.019) |                     |                     |                     |                     |
| Renovation efficiency 45-60%     |                     | 0.132***<br>(0.022) |                     |                     |                     |                     |
| Renovation efficiency 60%+       |                     | 0.248***<br>(0.069) |                     |                     |                     |                     |
| Renovation · sale post 2020      |                     |                     | 0.092***<br>(0.036) |                     |                     |                     |
| Renovation · renovated post 2020 |                     |                     |                     | -0.032<br>(0.046)   |                     |                     |
| Renovation · Riga                |                     |                     |                     |                     | -0.114*<br>(0.061)  |                     |
| Renovation · Liepāja             |                     |                     |                     |                     | -0.037<br>(0.033)   |                     |
| Renovation · mortgage            |                     |                     |                     |                     |                     | -0.035<br>(0.030)   |
| Observations                     | 39,284              | 39,284              | 39,284              | 39,284              | 39,284              | 39,284              |
| R-squared                        | 0.474               | 0.474               | 0.474               | 0.474               | 0.474               | 0.507               |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

Heating efficiency renovations seem to have generated a return amounting to about 10% of the apartment value (column 1). This value increases with the quality of renovations, from 6% for renovations which resulted in an efficiency gain of 30-45%, up to 25% for those resulting in an efficiency gain of 60%+ (column 2). The positive impact seems to be driven by energy price growth which started in 2021, due to Russia's invasion of Ukraine (column 3). However, construction cost increases did not affect profitability significantly (column 4). The low desirability to renovate in Riga, seen in the low uptake described in section 2.1, is also confirmed by lower returns in Riga (column 5). Surprisingly, the region of Liepāja, where a disproportionally high number of buildings had been renovated, did not see significantly different profitability compared to the rest of Latvia (excluding Riga). The mortgage dummy interaction with the renovation dummy is insignificant (column 6). As mortgages act as flags for transactions which were validated by banks, meaning there is no tax evasion, results suggest that the renovation premium is unaffected by tax evasion.

Estimates of returns which do not take into account cash flows prior to the sale of the apartment



can be seen in Table 2.

**Table 2:** Results without adjustments for loan payments and grants

|                                  | (1)                 | (2)                 | (3)                 | (4)                 | (5)                 | (6)                 |
|----------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Renovation                       | 0.109***<br>(0.014) |                     | 0.028<br>(0.033)    | 0.111***<br>(0.015) | 0.127***<br>(0.017) | 0.113***<br>(0.016) |
| Renovation efficiency 30-45%     |                     | 0.074***<br>(0.019) |                     |                     |                     |                     |
| Renovation efficiency 45-60%     |                     | 0.141***<br>(0.022) |                     |                     |                     |                     |
| Renovation efficiency 60%+       |                     | 0.252***<br>(0.069) |                     |                     |                     |                     |
| Renovation · sale post 2020      |                     |                     | 0.098***<br>(0.036) |                     |                     |                     |
| Renovation · renovated post 2020 |                     |                     |                     | -0.016<br>(0.046)   |                     |                     |
| Renovation · Riga                |                     |                     |                     |                     | -0.110*<br>(0.062)  |                     |
| Renovation · Liepāja             |                     |                     |                     |                     | -0.044<br>(0.033)   |                     |
| Renovation · mortgage            |                     |                     |                     |                     |                     | -0.039<br>(0.030)   |
| Observations                     | 39,284              | 39,284              | 39,284              | 39,284              | 39,284              | 39,284              |
| R-squared                        | 0.474               | 0.474               | 0.474               | 0.474               | 0.474               | 0.507               |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

These results are quite similar to estimates which take into account loan payments and utility bill savings prior to the sale described above. However, the difference is about 1 percentage point in all coefficients, indicating that  $NPV_i$ 's calculated in the accounting section of methodology are on average negative. This suggests that the value of the renovation comes from the expected future cash flows or the non-monetary value that renovations bring, such as aesthetic improvements, or possibly both of these factors.

Estimates of returns on investments in renovations without a government subsidy are shown in Table 3.

**Table 3:** Results with loan payment and grant adjustments

|                                  | (1)                  | (2)                  | (3)                  | (4)                  | (5)                 | (6)                  |
|----------------------------------|----------------------|----------------------|----------------------|----------------------|---------------------|----------------------|
| Renovation                       | -0.042***<br>(0.014) |                      | -0.120***<br>(0.033) | -0.030**<br>(0.015)  | -0.028<br>(0.017)   | -0.050***<br>(0.016) |
| Renovation efficiency 30-45%     |                      | -0.076***<br>(0.019) |                      |                      |                     |                      |
| Renovation efficiency 45-60%     |                      | -0.012<br>(0.022)    |                      |                      |                     |                      |
| Renovation efficiency 60%+       |                      | 0.109<br>(0.069)     |                      |                      |                     |                      |
| Renovation · sale post 2020      |                      |                      | 0.093***<br>(0.036)  |                      |                     |                      |
| Renovation · renovated post 2020 |                      |                      |                      | -0.112***<br>(0.046) |                     |                      |
| Renovation · Riga                |                      |                      |                      |                      | -0.140**<br>(0.062) |                      |
| Renovation · Liepāja             |                      |                      |                      |                      | -0.021<br>(0.033)   |                      |
| Renovation · mortgage            |                      |                      |                      |                      |                     | 0.006<br>(0.030)     |
| Observations                     | 39,284               | 39,284               | 39,284               | 39,284               | 39,284              | 39,284               |
| R-squared                        | 0.473                | 0.473                | 0.473                | 0.473                | 0.473               | 0.506                |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

The only case in which doing renovations showed no loss, was when the efficiency gain of these renovations was at least 60%+ (column 2). However, it is important to note that this is a scenario based on a strong assumption that the cost of retrofitting is not affected by whether the project receives additional government financing. It is possible that construction companies take the subsidy into consideration, increasing their prices, if they see that a project receives government funding. Therefore, these estimates should be interpreted with caution.

## 5 Discussion

Returns amounting to 10% of the apartment value indicate that the government subsidy programme has been successful in making retrofitting a worthwhile investment. However, if the goal is to renovate as many housing units as possible, the grant amount could have possibly been adjusted based on location and projected efficiency gain, to increase the number of buildings it was given out to, while keeping this endeavour monetarily attractive for people signing up for renovations. Never-

theless, obtaining an optimal amount of the subsidy cannot be done without making assumptions regarding future heating energy prices, future construction prices, and the future cost of borrowing.

One of the most interesting findings is the low return on investment in renovations in Riga. One of the drivers of this difference in the market value of renovations is the difference in renovation costs, which are 37% higher in Riga (see Table A1 column 1)<sup>6</sup>. This difference is partially explained by the fact that apartments in Riga were renovated at a later date, yet, controlling for the renovation start year, costs are still 20% higher in Riga (see Table A1 column 2). These high costs lead to a higher debt associated with the renovation, which the buyer of the renovated apartment must take on, lowering the value of the apartment. To validate the impact of these future loan payments, an additional specification which accounts for the share of renovation costs unpaid is employed (see Table A2). This specification shows that controlling for future costs in a general way decreases the effect of Riga on the renovation premium only slightly, however, enough to render it statistically insignificant. The high difference in renovation costs possibly points at insufficient competition in the construction market, as people ordering renovations become price takers. It is also possible that renovations are less appealing in Riga due to a lack of trust in governmental organizations or a higher supply of alternative energy efficient housing - new apartment buildings.

Comparing results of this study to the one conducted in Lithuania by Jakučionyte and Singh (2024), estimates of the price difference between retrofitted and non-retrofitted apartments are similar: 11% in Latvia vs 8% in Lithuania. Estimates which consider the costs of renovations differ drastically: 10% in Latvia vs -28% in Lithuania. This difference can be explained by the fact that the Lithuanian study contains sales between 2010 and 2023, while our study looks at sales between 2018 and 2024. A more recent sample shows a higher value of renovations since a larger portion of the data exists after a sharp increase of heating energy prices in 2022. The second explanation for the difference in results is the difference in the methodology when it comes to renovation cost accounting. The Lithuanian study assumes that all costs are paid off prior to the sale of the apartment, while our study only subtracts the loan payments made prior to the sale, which were found in the Credit Registry of Latvia.

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<sup>6</sup>There is some evidence suggesting renovation costs are also higher in Riga when measured as a percent of the apartment price. This might help in explaining why, even though the rise in construction costs has not affected the profitability of renovations in Latvia on average, retrofitting costs have been a more important factor for Riga so far. It also explains why the standardized government subsidy does not appear to have boosted renovation returns in Riga to the same extent that it has benefited owners elsewhere in the country.

## 6 Conclusion

The results of our analysis suggest that starting in 2021, subsidized heating energy efficiency renovations increase the price of apartments by 11% and, taking into consideration all the costs and benefits already incurred by owners of these apartments prior to their sale, generate returns amounting to 10% of the apartment value. Net cash flows related to the renovations prior to the sale are negative, implying that the value of renovations comes from the expected higher future heating energy prices or the non-monetary value that renovations bring, or most likely both. Returns increase with the energy efficiency gain obtained from the renovation, showing that people have become more conscious of their heating energy consumption. Returns are significantly lower in Riga, which can at least be partially explained by higher construction costs in this region. Retrofitting would not generate returns for the owners of apartments if government subsidies were not made available, underlining the importance of EU funds in the process of improving the sustainability of the housing stock of Latvia.

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## A Appendix

### A.1 Mapping

#### ALTUM and Credit Registry

The company registration number is available in both datasets, making precise matching possible. The companies in question are the residential property management companies to which buildings to be renovated were registered. It is through these companies that the loans for renovations were signed and later redistributed to the apartment level based on the square meterage. The loan origination date is available in the ALTUM data only if ALTUM themselves issued the loan. Otherwise, the grant issuance date is used as a proxy for the loan origination date in the ALTUM data and matched to the Credit Registry’s loan origination date. As these dates may differ slightly across datasets, we allow for a maximum mismatch of dates to be 30 days. The loan amount is also available in the ALTUM data only if ALTUM themselves issued the loan. For the rest of the renovation projects, it is calculated as the total project cost net the grant given by ALTUM. These values are also allowed to not match exactly. The loan is assigned based on the lowest mismatch between the cost of the renovation and lent amount, but subject to the constraint of a maximum mismatch of 10%. Only loans which are already matched by the company registration number and loan origination date are considered.

Two additional fields were used to map loans to renovations, if they were available. If the loan was given out by ALTUM, we then filtered the Credit Registry for loans given out by this entity prior to matching. 152 loans were mapped with this additional filter. If the ALTUM data showed that there was a guarantee attached to the renovation project, it was also matched to the Credit Registry by the guarantee amount, allowing for the absolute mismatch to be up to 10% of the guarantee amount. 184 loans were mapped with this additional filter. While this matching is not exact, it is relatively precise as the likelihood of the same property management company taking out multiple loans of close to the same amount within 30 days is low. This is especially the case when the aforementioned additional filters are applied. An exception is when the same property management company is responsible for multiple buildings which had signed up for renovations. In this case, one loan may be mapped to multiple renovation projects. To remedy this, when a loan was a close match to multiple renovation projects only cases where the loan value was an exact match to the renovation cost were mapped.

#### Additional data sources

The heating energy utility price index from the [Central Statistical Bureau of Latvia \(2025a\)](#) was mapped by date to the monthly Credit Registry loan payment date, to calculate the changes in the heating energy tariff, which in the ALTUM dataset was only available for the date when the renovation process began. This time series was necessary to calculate the heating utility savings which accumulated up to the sale date. Similarly the Latvian government 10-year bond yield, taken from the [Federal Reserve Bank of St. Louis \(2025\)](#), was mapped by date, to be used as the discount rate in the NPV calculations. Lastly, Credit Registry data was mapped for an additional purpose of seeing whether the purchase of the apartment was financed with a loan. This was also done based on the proximity of the loan amount and transaction amount, with a maximum mismatch of 10%; loan origination date and transaction date, with a maximum mismatch of one year; where the loan collateral apartment cadastre number matches the cadastre number of the apartment which was sold; and the loan is a mortgage.

**Table A1:** Differences in renovation costs between Riga and the rest of Latvia

|              | (1)                 | (2)                 |
|--------------|---------------------|---------------------|
| Riga         | 0.373***<br>(0.008) | 0.197***<br>(0.007) |
| Observations | 18,037              | 18,037              |
| R-squared    | 0.369               | 0.383               |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: [ALTUM \(2025\)](#).

Notes: The dependent variable is a natural logarithm of renovation cost per square metre after a grant; column (1) shows the results of the regression of renovation cost on a Riga dummy; column (2) shows the results of the regression of the renovation cost on a Riga dummy and renovation start year dummies.

**Table A2:** Effect of the unpaid loan amount

|                          |                       |
|--------------------------|-----------------------|
| Renovation               | 0.3917***<br>(0.087)  |
| Renov. cost. % unpaid    | -0.0035***<br>(0.001) |
| Renovation · <i>Riga</i> | -0.0907<br>(0.061)    |
| Observations             | 39,284                |
| R-squared                | 0.474                 |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Credit Registry of Latvia; [The State Land Service \(2025\)](#); [ALTUM \(2025\)](#).

Notes: The regression specification is similar to one in Equation 8, except the renovation dummy interaction with the Riga dummy is added, and the % of renovation cost which has not yet been paid at the time of the sale of the renovated apartment is added to the RHS of the equation.