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Long-Term Dynamics of New Residential Supply: A Case Study of the Apartment Segment in Sweden

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Abstract: Since the size of the homeownership ratio differs significantly between countries, it is important to understand the mechanisms that lie behind the decrease or growth of certain sectors of the housing market such as rentals and housing cooperatives. The aim of this study is to analyze the long-term dynamics of the new residential supply in Sweden's three largest cities for the period of 1990–2020 and estimate in what way market fundamentals affect it through new construction and housing conversions. We apply panel data methodology and, in distinction to previous research, consider the development of the housing market (urban growth) as physical volume. The results demonstrate that structural changes are driven mainly by fundamental demand factors and that the displacement effect occurs primarily in the market's rental sector and not in the owner-occupied segment. The apartment price per square meter, together with mortgage interest rates, are the major driving factors in the process of converting dwellings into housing cooperatives. Fundamental variables that affect new construction in both the rental and housing cooperative sectors are population and income growth. In the presence of a rent control environment, the rent or price level does not contribute to adding new units to the total housing stock.

Keywords: housing supply; Swedish apartment market; panel data analysis

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1. Introduction

Housing is one of the basic necessities. Some people prefer to own a house; however, many rent due to individual circumstances, generational trends and flexibility when moving.

Housing is important for the economic vitality of communities. Therefore, the growth of the housing sector through new construction, renovations and property conversions from other real estate sectors as well as a balanced development of different housing forms is, in the long run, an essential component of urban growth. Kemeny (1981) argues that housing policy should be "tenure-neutral"; that is, the role of governments in housing should be to maximize effective consumer choice by encouraging the development of a wide range of tenures at comparable cost [1]. However, the housing market structure differs between countries. The share of the private rental market in European countries in 2020 varied between 3.9% in Romania and 57.7% in Switzerland. On average, about two-thirds of the population in Europe lives in owner-occupied houses or apartments (69.7%) and about one-third (30.3%) lives in rental housing [2]. (Source: Eurostat, 2020. https://ec.europa.eu/eurostat/cache/digpub/housing/vis/01_01_01/index.html, accessed on 17 December 2021).

Haffner (2003) emphasizes that the government should not assist one tenure more than another; consumers of housing services should be able to make a free choice [3]. However, some misbalances in this process can be observed in some European countries such as, for example, Sweden. The Swedish housing market has been characterized as dysfunctional for a number of years. Despite rapid urban growth over recent decades, an insufficient number of rental accommodations have been built. This has resulted in long queues for rental housing in major Swedish cities, and a housing shortage has been reported by 70% of municipalities (The Government of Sweden, 2021).

As Andersson & Turner (2014) point out, public rental housing in Sweden has since the 1930s been a key element in governmental policies intended to establish a housing system that would secure high-quality, affordable accommodation for all [4]. However, since the early 1990s, changes in housing policies have been directed toward more local decision-making concerning tenure conversion and turning public rental apartments into market-based (cooperative) ones. As Andersson & Turner (2014) documented, in 1990, 32% of all residents in Sweden's capital city, Stockholm, lived in rentals, while this proportion in 2010 stood at 18% [4]. They argue thus that these policies have resulted in increasing levels of socio-economic segregation in Stockholm.

The small size of the rental housing market might be detrimental to macroeconomic stability. Rubaszek & Rubio (2020) provide evidence that the response of house prices to macroeconomic fundamentals is attenuated by the size of the private rental market [5]. Therefore, it is important to understand the mechanisms that contribute to long-term changes in the housing market structure, and more specifically, the continuous decrease in the rental sector.

Various government policies, such as the implementation of rent control, can lead to crowding in- and out effects for different sectors of housing markets by reducing the number of available housing units. Accordingly, Molloy (2020) states that one of the substantial gaps in the literature is the relationship between regulation and rents [6]. She underlines that a better understanding of the effects of regulation on the relative supply of owner-occupied housing and the ability of households to transit from renting to owning might be helpful. Keeping this in mind, we consider Sweden as a good case country for an investigation of the mechanisms that contribute to the development of housing market structure (More details of the urban dynamics and new housing supply in Sweden are presented as the "Swedish case" in Section 4.1).

The aim of this paper is therefore to analyze the long-term dynamics of the new residential supply in Sweden's three largest cities and estimate in what way market fundamentals affect it through new construction and housing conversions. The research questions are as follows:

(1) How do fundamental factors of supply and demand contribute to multifamily housing stock dynamics over the long run through (a) the new construction of multifamily apartments and (b) added multifamily apartment stock through dwelling conversions.
(2) Are there any displacement effects in the form of crowding out or crowding in from one sector to another? In other words, to what extent do the rental and cooperative apartment sectors contribute to the growth or decrease in the total new construction of multifamily apartments and total property conversions to housing?

An analysis of new housing supply and its dynamics over the long run is important for the development of efficient housing policies that avoid future displacement effects for certain sectors of the housing market. This paper is based on theoretical and practical implications from existing research conducted on single-family houses, and it contributes to the body of knowledge in this area by adding empirical findings from the analysis of the new supply of homes in the apartment sector of several Swedish cities' housing markets. It also applies models that are based on the development of the housing market (urban growth) as physical volume. Our results indicate that a displacement effect occurs primarily through property conversions in the market's rental sector and not through the owner-occupied segment.

The paper proceeds as follows. Section 2 provides a brief literature review on new housing supply. Section 3 proposes a theoretical model of new supply coming from new construction and dwelling conversions as well as an assessment of displacement effects from excess demand that flows out from the rental sector toward the housing cooperative sector. Section 4 describes data and presents the "Swedish case", and Section 5 presents empirical results from the regression analysis, which is then followed by analysis and discussion in Section 6. Section 7 includes a conclusion and policy implications.

2. Literature Review

DiPasquale (1999) underlines the complexity of the determinants of new housing construction [7]. He argues that housing supply is determined not only by the production decisions made by builders of new units but also choices that owners (and their agents) make concerning the conversion of existing housing stock. One of the determinants of long-term housing supply widely mentioned in the literature is thus its elasticity to price changes.

2.1. Definitions of Housing Supply Elasticity

Glaeser et al. (2008) demonstrated that the elasticity of housing supply plays a significant role in house price dynamics [8]. Although house price bubbles might be observed in the markets where housing supply is relatively inelastic, Ball et al. (2010) argue that new construction might press the bubbles down [9]. At the same time, high elasticity of supply might lead to an over-supply of properties on the market [10].

Mayer & Somerville (2000) define elasticity of housing supply as the percentage change in the entire housing stock from a percentage change in house prices [11]. It should be differentiated from elasticity of housing starts, which describes the change of flow in new construction. Housing starts' elasticity is sensitive to the length of time over which it is calculated; the longer the period, the lower the elasticity [11]. Thus, the major difference between housing supply elasticity and that of housing starts is that a one-time increase in house prices leads to a temporal rather than permanent increase in new construction, yielding a finite increase in the stock of housing [11]. Wheaton (1999) provides evidence that in different sectors of the property market, construction lags might be quite different in length [12].

Another concept that is used to understand the elasticity of housing starts is development elasticity, which Murphy (2018) defines as the percentage change in the development rate associated with a 1% change in house prices, where the change in price also affects expectations concerning future profit [13]. The author argues that forward-looking behavior plays a considerable role in lowering development elasticity when prices are high due to timing the market.

In distinction to house price dynamics and its effects on housing supply elasticity, which is well examined in a large number of research studies, the dynamics of new housing supply (or housing stock adjustments) over the long run has not received much attention in the literature. A brief summary of existing research on this issue is presented below. In addition, Table A1 in Appendix A presents an overview of the major factors that affect housing supply in physical volume form.

2.2. Fundamental Determinants of Housing Supply

DiPasquale & Wheaton (1994) estimates housing stock adjustments in a long-term equilibrium framework [14]. They model new construction as a function of new housing price, short-term real interest rate, price of agricultural land, construction costs, lagged housing stock, the change in aggregate employment and number of months on the market. They found that long-term price elasticities vary from 1.0 to 1.2 for new construction and from 1.2 to 1.4 for housing stock. The authors emphasize that construction reflects the long-term adjustment of the current stock. Housing prices affect new construction only when current stock deviates from its long-run equilibrium level for this price level. Therefore, changes in housing prices stimulate the development of urban land and drive long-run urban spatial growth [14].

Mayer & Somerville (2000) have developed an empirical model of new single-family housing supply that reflects the role of land development and urban growth. They report a fairly moderate response of supply to house price changes, around 0.8%. Moreover, they claim that housing starts' elasticity decreases over the long run [11]. Similarly, Riddel (2004) examines housing market price and stock dynamics in the US and found that long-term price elasticity of supply lies between 0.025 and 0.49, which is higher than reported by Wigren & Wilhelmsson (2007) for Sweden, with long-term supply price elasticity of approximately 0.10 and construction price elasticity of −0.16 [15,16]. It is also lower than reported in previous studies by DiPasquale & Wheaton (1994) and Owusu-Ansah (2014) [14,17]. The latter estimated price elasticity of supply in Aberdeen, Great Britain, in the range of 2.0 to 3.2 for housing starts and 0.01 to 0.02 for housing stock. In another study, Lerbs (2014) reported the average long-term price elasticity of new single-family housing supply in German counties and cities to be 0.33 [18].

Riddel (2004) found that price appreciation signals developers to build more units about two periods later, which is consistent with a two-year building and permitting horizon [15]. Wigren & Wilhelmsson (2007) moreover found that on average, it takes around 4 years for a shock to be fully incorporated into the housing stock [16]. An analysis by Stevenson & Young (2014) reveals that although developers did respond to disequilibrium in supply, the rate of adjustment is relatively slow. In contrast, disequilibrium in demand did not impact upon supply, suggesting that inelastic supply conditions could explain the prolonged nature of the boom [19]. It confirms that supply adjusts slowly to changes in market conditions from the demand side because housing markets are inefficient, as proposed by Case & Shiller (1989) [20].

Riddel (2004) argues that supply shocks might arise from a variety of sources such as changes in building material costs, wages, or lending rates for development loans [15]. Somerville (1999) found that increases in costs do reduce housing starts in the USA [21], and Lerbs (2014) suggests that the local ratio of existing home prices to housing construction costs and past local permit rates act as important drivers of new local housing investment in Germany [18]. In addition, Owusu-Ansah (2014) found that changes in house prices, time on market, planning regulation, lagged stock and lagged and future housing starts are the main factors that influence new residential construction in Aberdeen, Great Britain [17].

2.3. Role of Regulatory Policies

Molloy (2020) provides an extensive overview of housing supply regulation effects on housing affordability including such dimensions as housing costs and household income [6]. A study by Landis & Reina (2021) confirmed that more stringent land use regulations are associated with higher housing values and rents. These effects are magnified in faster-growing and more prosperous economies, thus decreasing the affordability of housing over the long run. To make housing more affordable and stimulate new construction, governments might subsidize either housing developers or low-income households [22].

Murray (1999) found that public housing for low-income households has added to the total stock of housing, while conventionally financed subsidized housing for moderate income households most likely adds little or nothing to the total housing stock [23]. Furthermore, Sinai & Waldfogel (2005) discovered that government-subsidized housing units crowded out low-income housing units that would otherwise be provided by the private sector [24].

Government policies might impact the elasticity of housing supply, since they play a deterministic role of what is being built and when. Hence Ball et al. (2010) suggest that supply elasticities are highly variable and, amongst other factors, related to existing land-use patterns, topology and planning policy [9]. Accordingly, Pryce (1999) concludes that private-sector new construction is sufficiently sensitive to the overall amount of land available for construction [25].

Another example of government policies is the implementation of rent control. However, it might lead to crowding in and out effects for different sectors of housing markets. Jud et al. (1996) reveal that rent control hurts renters in the long run by making rental markets less efficient and reducing the number of available rental units [26]. Therefore, analysis of new housing supply and its dynamics over the long run is important for the development of efficient housing policies that avoid displacement effects for certain sectors of the housing market in the future.

2.4. Approaches to Estimating Housing Supply Dynamics

DiPasquale (1999) points out that much of the literature focuses on the supply of the single-family owner-occupied houses, while knowledge of new supply determinants regarding multifamily rental housing units is very limited. The reason for this is the lack of available statistical data and longer time frames needed to provide an opportunity for empirical estimations and modeling. One of the few studies on this topic is an article by Follain et al. (1993), who analyze the effects of tax reform on the supply of multifamily housing in the United States [27]. A similar study by Warsame et al. (2010) for Sweden indicates that an interest subsidy has a positive impact on the total production of housing units and especially multifamily units [28].

Two major approaches can be found in the empirical literature for the analysis of housing supply: (1) housing supply in the form of residential investments (as financial value) and (2) housing supply in the form of the number of housing units under construction (as physical volume in several dwellings). The study by Wigren & Wilhelmsson (2007), as well as the earlier study by DiPasquale (1999), contains a good overview of the research on the dynamics of housing investment and housing stock [7,16]. Furthermore, Riddel (2004) argues that housing markets, similar to other durable goods markets, might be viewed as having a flow and stock dimension [15]. The flow dimension is the sum of the construction of new residential units and depreciation of existing units or net investment. Therefore, the long-run supply, or stock of housing, is the accumulation of net investment [15].

Riddel (2004) emphasizes that in many models of housing investment, new construction is directly related to the price level, implying that an overall increase in the price level leads to permanent increases in new construction [15,29–31]. These models hypothesize that those areas with high price levels should have higher construction rates, whereas less investment will be observed in areas with relatively low housing prices. Riddel (2004) also underlines that this restriction is unrealistic, since slow growth in housing stocks is often observed in conjunction with a relatively high price level [15].

In distinction to the first approach, our article is focused on modeling housing supply with the second approach (in physical form). The major findings from previous research are that market fundamentals of supply and demand such as house prices, rent levels, construction costs, land prices, population, income and interest rates are the major driving factors behind new housing construction (see Table A1 in the Appendix A). In the next section, we develop an econometric model for estimating the effects of these factors on housing supply dynamics. When we consider the physical supply, it is important to mention that there is no standard housing quantity, since housing units might vary considerably in quality dimensions, size and with respect to other features.

3. The Model and Methodology

The specification of the model is based on DiPasquale and Wheaton's (1992) 4-quadrant model for markets and space that describes the interaction between demand and supply forces over the short and long run [32]. Their model emphasizes that demand comes from the occupiers of space, whether they are tenants or owners. The household demand for space depends on income and the costs of occupying that space relative to the costs of consuming other commodities. Rent is the cost of occupying space for households. Rent is determined in the property market for space, while price is determined in the asset market for ownership. The demand for space depends on rent, R, and other exogenous economic factors such as income and the number of households, E. In equilibrium, the demand for space, D, is equal the stock for space, S. Taken that the stock as given in the short run rent is determined so that the demand is equal to the stock,

$$D(R,\ E) = S \tag{1}$$

Change in population, income, and financing conditions shift the demand and drive house prices. Lower interest rates, for example, imply that for the same annual payment (rent), a household can afford to pay a higher purchase (asset) price. Accordingly, a single decision by the user/owner determines both rent and price in the short run. Simultaneously, the same economic and capital market conditions determine the construction and equilibrium market for space in the long run. For example, if construction is very elastic with respect to asset prices, then the levels of prices and rents will not be affected much in the long run, while if supply is inelastic, the significant growth in price and rents is expected in the long run. Thus, contribution to differences in the local level in the degree to which house prices and rents might change in the long run will depend on growth of population, Pop, change in the real earned income, Inc, and the real mortgage interest rates, r. In this article, we use population growth as one of the independent variables in regression due to (1) the non-stationary character of the data and (2) the fact that household size in Sweden has not changed greatly during the 1990–2020 period and is around 2.1 persons per household (Source: SCB Sweden). Thus, this population growth will represent the effect of population dynamics in a better way.

The growth of house prices and rents will stimulate new housing production as well as conversions of other real estate properties such as commercial premises or industrial buildings into residential dwellings. Therefore, the total change in the aggregate housing stock should include the number of dwellings constructed, *NC*, and dwelling conversions from other property market sectors to housing in a given period, *DC*, in both the rental and housing cooperative sectors, minus losses from the stock measured by depreciation (removal rate), d:

$$\Delta S = NC + DC - dS \tag{2}$$

In this paper, we assume that the depreciation rate is equal between different tenure forms. The property removal rate in Sweden is quite low, since properties are well maintained. Therefore, in our analysis, for simplicity, we set the physical depreciation rate close to zero, $d = 0$.

According to DiPasquale and Wheaton (1992), construction depends on the price of the assets relative to the costs of replacing or constructing them [32]. Previous research by Mayer & Somerville (2000) point out that the new housing construction is a flow, and therefore, the model should be constructed on changes in independent variables such as housing prices and costs (first differences) rather than on levels [11]. Thus, the number of dwellings constructed as a response from the supply side is a function of change in prices, *P*, rent level, *R*, construction costs, *K*, (including costs of building materials, labor, and financing costs), and cost of land, *L*. Prices as well as rents for new construction depend on the aggregated price and rent level for existing stock as well as expectations about its future development. These data are not available for Sweden; therefore, we use price and rent levels for existing stock as a proxy for prices and rent levels in new construction.

$$NC = f(\Delta P, \Delta R,\ \Delta K,\ \Delta L) \tag{3}$$

For housing conversions, the number of dwellings added to housing stock is a function of change in prices, *P*, and rent level, *R*, from the supply side and population growth, *Pop*, real earned income, *I*, and mortgage interest rates, *r*, from the demand side of the housing market:

$$DC = f(\Delta R,\ \Delta P, \Delta Pop,\ \Delta Inc, \Delta r) \tag{4}$$

Inserting (3) and (4) into (2), we will give the formula for the total change of the housing stock:

$$\Delta S = f(\Delta R,\ \Delta P, \Delta Pop,\ \Delta Inc, \Delta r,\ \Delta K,\ \Delta L) \tag{5}$$

To assess the effects of different factors on the change of housing stock over the long run through new construction and dwelling conversions in rental and housing cooperative sectors of the market, we estimate the set of models presented in Table 1.

Table 1. Econometric models.

Models and Econometric Equations	Equation Number
1. Change in the total multifamily housing stock $\Delta S_i = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + b_6\ \Delta K_i^{ren} + b_7\ \Delta L_i^{ren} + b_8\Delta K^{coop} + b_9\ \Delta L_i^{coop} + e_i$	(6)
2a. New construction of rental apartments $NC_i^{ren} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + b_6\ \Delta K_i^{ren} + b_7\ \Delta L_i^{ren} + e_i$	(7)
2b. New construction of housing cooperative apartments $NC_i^{coop} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + b_6\ \Delta K_i^{coop} + b_7\ \Delta L_i^{coop} + e_i$	(8)
3a. Dwelling conversions to rental apartments $DC_i^{ren} = b_0 + b_1\Delta\ R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + e_i$	(9)
3b. Dwelling conversions to the housing cooperatives sector $DC_i^{coop} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + e_i$	(10)
4a. Displacement effects for total new apartments construction from the rental sector $NC_i^{total} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + b_6\ \Delta K_i^{ren} + b_7\ \Delta L_i^{ren} + \sigma_1 NC_i^{ren} + e_i$	(11)
4b. Displacement effects for total new apartments construction from the housing cooperatives sector $NC_i^{total} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + b_6\ \Delta K_i^{coop} + b_7\ \Delta L_i^{coop} + \sigma_2 NC_i^{coop} + e_i$	(12)
5a. Displacement effects for total dwelling conversions from the rental sector $DC_i^{total} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + \varphi_1 DC_i^{ren} + e_i$	(13)
5b. Displacement effects for total dwelling conversions from the housing cooperatives sector $DC_i^{total} = b_0 + b_1\Delta R_i + b_2\Delta P_i + b_3\Delta Pop_i + b_4\Delta Inc_i + b_5\Delta r + \varphi_2 DC_i^{coop} + e_i$	(14)

In econometric Equations (6)–(14) in Table 1, the subscript i denotes the location (i.e., given city). Variable Δr is the change in real mortgage interest rate, and this term is common across all locations in the dataset. Variables ΔK_i^{ren} and ΔL_i^{ren} represent changes in construction and land costs for rental apartments, and ΔK_i^{coop} and ΔL_i^{coop} represent changes in construction and land costs for housing cooperative apartments.

In line with the literature review presented in Section 2, we expect a positive sign for population, income and housing prices in existing stock, and negative signs for mortgage interest rates, construction and land costs.

We define displacement effects as a situation where the rising new construction either of rental or housing cooperative apartments leads to a decrease in total new construction (crowding out) or stimulates the total new construction of apartments in multifamily houses (filling in) in addition to impacts from different economic factors. To assess the displacement effects of housing cooperatives, its data are combined with data for rental apartments. The main strategy is to run a cross-section regression of apartment construction and dwelling conversions controlling for other fundamental drivers of housing supply as in line with the methodology in previous research literature [11,28,33].

Coefficients σ_1 and σ_2 in expressions (11) and (12) represent crowding in and out effects for total new multifamily housing constructions coming from respective new construction in the rental and housing cooperatives sectors.

If coefficient σ_1 equals 0, that would indicate that the new construction of rental apartments has no effect on the total number of newly constructed housing dwellings in multifamily houses. If it instead equals −1, that would imply complete crowding out and indicate that the new construction of rental apartments does little to increase the total new construction of multifamily dwellings. On the other hand, if σ_1 equals 1, total new construction will grow twice as much as the increase in rental apartments, that is, 100% filling in. The same principle is applied for the coefficient σ_2 regarding the impact of the new construction of housing cooperative apartments.

Coefficients φ_1 and φ_2 in expressions (13) and (14), similar to expressions (11) and (12), represent displacement effects for the total number of dwelling conversions coming from the netto of conversions that occur in the rental and housing cooperatives sectors, respectively.

If coefficient φ_1 equals 0, that would indicate that the netto of conversions to rental apartments has no effect on the total number of multifamily housing units added to housing stock through conversions. If it instead equals −1, that would imply a complete crowding out and indicate that the netto of conversions to rental apartments does little to increase the total conversions to multifamily dwellings. On the other hand, if σ_1 equals 1, total new conversions will grow twice as much as the increase in the netto of conversions to rental apartments, that is, 100% filling in. The same principle is applied for the coefficients σ_2 regarding the impact of the netto of dwelling conversions in the housing cooperative sector.

4. Data

4.1. The Swedish Case

4.1.1. Urban Growth and New Housing Supply in Sweden

New housing supply in Swedish cities is a subject of continuous discussion and analysis at both the national and regional levels (see, for example, publications of the Swedish National Board of Housing, Building and Planning [34–39]). During the last three decades, many more housing cooperative apartments were built than rental apartments despite the high demand for rental apartments and long queues [40]. The total number of apartments in multifamily houses has grown by 27% between 1990 and 2020, while the total number of rental apartments in multifamily houses in Swedish cities has decreased by 13%, and the number of housing cooperative apartments has increased by 123% over the same period of time (Table 2). This implies that together with the process of urban growth at 27% of the multifamily housing market segment, we observe displacement effects (−13% decrease in rental sector and +123% in housing cooperatives sector) in housing stock dynamics. These effects reflect the way the housing market structure changes over the long run.

Table 2. The housing stock in Sweden, year 1990–2020.

Housing Market	Single-Family Houses				Apartments in Multifamily Houses				Rental Apartments in Multifamily Houses				Housing Cooperative Apartments in Multifamily Houses			
Year	**1990**		**2020**		**1990**		**2020**		**1990**		**2020**		**1990**		**2020**	
City	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Stock-holm	191,445	24	253,516	25	595,327	76	758,370	75	425,495	72	324,813	43	169,832	29	433,557	57
Gothen-burg	127,865	36	159,418	36	226,972	64	281,951	64	171,238	75	173,716	62	55,724	25	108,235	38
Malmo	85,532	35	105,979	34	160,196	65	204,178	66	99,381	62	108,175	53	60,815	38	96,003	47
Sweden	1,710,282	44	1,914,270	43	2,170,535	56	2,583,310	57	1,554,457	72	1,502,851	58	616,078	28	1,080,459	42
Growth for Swedish cities, year 1990–2020				28				27				−13				123
Growth for Sweden, year 1990–2020				12				19				−3				75

Source: SCB Sweden; authors calculations.

4.1.2. Housing Market Structure in Swedish Cities

While for single-family houses, the share of ownership is relatively high (the vast majority of single-family houses are in private ownership), the share between rental and housing cooperative housing varies for the apartment sector. For example, in major Swedish cities, the share of the apartment sector varies between 64 and 75% of the total housing stock in 2020, of which the share of rental apartments varied between 43 and 62%. The rest consists of apartments in a form of housing cooperatives (Table 2).

4.1.3. Institutional Factors in the Context of the Swedish Housing Market

Swedish housing policies in the early 1990s experienced a pivotal shift from a housing system that was mainly based on a large share of public housing to a more market-based system that allowed tenant conversions to cooperative housing. In addition, financial liberalization in the banking sector allowed for better financing solutions for existing homes and new housing development. At the same time, rental regulations in the housing sector limited investments in new housing development to some extent [41].

As a result of these policies, as shown in Table 2, the apartment market sector structure has changed over three decades. We can observe a decrease in the rental sector (minus 29% for Stockholm, minus 14% in Gothenburg and minus 9% in Malmo) and growth in the housing cooperative sector to the same extent, respectively. For the whole of Sweden, the rental sector decrease between 1990 and 2020 was minus 13%. It is worth noting that the share of single-family housing in total housing stock has not changed significantly (it was 44% in 1990 and 43% in 2020).

This restructuring of the apartment market in major Swedish cities has occurred primarily for two reasons: (1) new apartment construction; (2a) property conversions from both office and industrial sectors into housing, and (2b) conversions of rental dwellings to cooperative housing apartments. In Section 5, we present empirical results from estimations of models 1–5 that represent this long-run restructuring of the housing market.

4.2. The Dataset

The data include the period of 1990–2020 regarding the three largest cities in Sweden. Data sources and a detailed description are presented in Table A2 in the Appendix A. Data are unbalanced with some missing observations in either the beginning or end of the time period. Summary statistics are presented in Table 3.

Table 3. Summary statistics of data.

Variables	Unit	Obs.	Mean	Std. dev.	Min.	Max.
New construction of rental apartments	Dwellings	90	1628.822	1225.466	278	5514
New construction of housing cooperative apartments	Dwellings	90	1761.644	1936.032	10	8819
Netto of conversions to rental apartments	Dwellings	93	141.1075	226.7104	−46	1032
Netto of conversions to housing cooperative apartments	Dwellings	93	299.4409	308.1546	−346	1496
Rental apartment stock	Dwellings	93	232,967.1	122,883	99,381	439,057
Housing cooperative apartment stock	Dwellings	93	146,023.7	113,604.5	55,724	442,936
Total apartment stock in multifamily buildings	Dwellings	93	379,097.9	223,744.6	160,196	829,655
Rent per square meter	SEK	53	1010.81	147.7724	778.1182	1334.373
Apartment price per square meter	SEK	75	26,780.47	18,588.57	2934.346	75,179.64
Population	Inhabitants	93	1,158,798	598,119.6	529,315	2,391,990
Population growth	Inhabitants	90	13,795.54	10,078.1	3394	39,083
Total earned income per capita	Thousand SEK	87	211.8199	59.93995	111.8399	351.2326
Mortgage interest rate	Percent	84	3.151127	2.156006	−0.1877261	7.729706
Construction costs per square meter for newly built rental apartments	SEK	76	20,081.17	6422.699	8299.674	33,684.54
Land costs per square meter for newly built rental apartments	SEK	76	2715.752	1421.144	695.5837	7047.27
Construction costs per square meter for newly built cooperative apartments	SEK	76	25,377.88	9653.017	9615.283	48,413.08
Land costs per square meter for newly built cooperative apartments	SEK	76	7008.156	4649.454	1118.098	21,047.41

Source: SCB Sweden; Central Bank of Sweden; Swedbank Sweden.

Panel Unit Root Tests

Data are tested for stationarity with the help of the unit root test used by Im et al. (2003), which allows for heterogeneous autoregressive roots (the IPS test) [42]. The results of IPS stationarity tests are presented in Table A3 in Appendix A. As shown in Table A3, the majority of independent variables in the model(s) are non-stationary at levels but stationary at first differences. Dependent variables such as the new construction of apartments and netto of dwelling conversions are stationary at levels and first differences.

5. Empirical Results

Models 1–5 were estimated by fixed and random effects regression. The Hausman test is performed to determine a better choice between fixed and random effect regressions for each of the models' estimations. Results are reported in Tables 4–8.

Post-estimation tests include Breusch–Pagan statistics for cross-sectional independence in the residuals of a fixed effect regression model and Wald statistics for groupwise heteroscedasticity in the residuals of a fixed effect regression model. Breusch–Pagan tests have provided evidence of cross-sectional independence in the residuals in all regressions. It implies that estimators are consistent.

Results of the Wald test indicate no deviations from homoscedastic errors in the context of panel data for all models except for model 5. The observed heteroscedasticity in model 5 indicates that the assumption of normality is violated at least in asymptotic terms. Although in terms of small sample properties, simulations of the test statistics have shown that its power is very low in the context of fixed effects, and this test should be used with caution.

For all regressions, a Wooldridge test for autocorrelation and Breush and Pagan Lagrangian multiplier test for random effects were used. In all models, no autocorrelation was detected nor was any heteroscedasticity in error terms for random effects estimations reported. It implies that estimators are efficient.

In addition, Variance Inflation Factor (VIF) tests that represent a measure of the amount of multicollinearity in a set of multiple regression variables are presented in Tables A4–A8 in Appendix A. The results of VIF tests provide evidence that multicollinearity is not observed. High values for VIF tests for new construction and the netto of dwelling conversions are expected, since these independent variables are components of the dependent variable in models 4 and 5.

Estimation results for model 1, "Dynamics of the total housing stock of multifamily dwellings over the long run", are presented in Table 4.

Table 4. Dynamics of the total housing stock of multifamily dwellings over the long run.

Variables	Model 1. Dependent Variable: Change of the Total Stock of Multifamily Dwellings			
	Fixed Effects		Random Effects	
	Coefficient	**t**	**Coefficient**	**z**
Const	−0.0424 *	−1.84	−0.0026	−0.27
Rent per square meter, SEK	−0.0828	−2.54	−0.0624 *	−1.83
Apartment price per square meter, SEK	0.0011	0.12	−0.0053	−0.57
Population growth, inhabitants	0.0053 **	2.19	0.0011	1.15
Total earned income per capita, thousands SEK	0.2428 **	2.53	0.2346 **	2.29
Mortgage interest rate, percent	−0.0026 *	−1.90	−0.0033 **	−2.40
Construction costs per square meter for rental apartments	0.0046	0.55	0.0060	0.67
Land costs per square meter for rental apartments	0.0037	1.04	0.0042	1.11
Construction costs per square meter for cooperative apartments	−0.0065	−0.61	−0.0021	−0.18
Land costs per square meter for cooperative apartments	−0.0079 **	−2.18	−0.0098 **	−2.59
Number obs.	47		47	
Number of groups	3		3	
R-squared: within	0.4228		0.3716	
between	0.0179		0.0013	
overall	0.2118		0.3351	

Table 4. *Cont.*

Variables	Model 1. Dependent Variable: Change of the Total Stock of Multifamily Dwellings			
	Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z
Hausman chi2	2.43			
Prob > chi2	0.9826			

Note: *, ** denotes statistical significance at the 10% and 5% level, respectively.

R-squared for regression on total stock of multifamily dwellings is 34%, which implies that fundamental variables can explain about one-third of the total change in stock. Moreover, random effects regression estimators are more efficient than fixed effects estimators according to the Hausman test.

Rent level, mortgage interest rate and land costs have a negative effect on the development of housing stock. A 1% higher growth in rent level decreases the growth rate of the total housing stock of multifamily buildings by 0.0624%. Rent level might have both negative and positive effects, depending on whether the effect is generated from demand or supply. For example, higher rents decrease demand for rental housing but increase new construction on the supply side of the market. In this case, the negative effect implies that driving forces from the demand side prevailed during the estimated period. Higher growth rate in land costs per square meter for multifamily apartments decrease the growth of the total stock of multifamily buildings by 0.0098%. An increase in mortgage interest rate by 1% decreases the growth of the total housing stock of multifamily buildings by 0.0033%. The total earned income has a positive effect, implying that a 1% increase in income growth leads to a 0.2346% increase in the total housing stock of multifamily buildings. This is the highest impact among variables.

Estimation results for model 2a, "Dynamics of the new construction of dwellings in the rental sector", and model 2b, "Dynamics of the new construction of dwellings in the housing cooperative sector", are presented in Table 5.

Table 5. Dynamics of the new construction of dwellings.

Variables	Model 2a. Dependent Variable: New Construction of Rental Apartments				Model 2b. Dependent Variable: New Construction of Housing Cooperatives			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z	Coefficient	t	Coefficient	z
Cost	0.1793	0.07	−0.7426	−0.73	−0.4611	−0.20	−5.1156 ***	−5.44
Rent per square meter, SEK	−5.3911	−1.46	−4.9694	−1.39	−9.3021 ***	−2.85	−11.0016 ***	−3.31
Apartment price per square meter, SEK	−0.1165	−0.13	−0.0680	−0.08	−1.7926 *	−2.03	−1.0093	−1.18
Population growth, inhabitants	0.6956 ***	2.66	0.7960 ***	7.62	0.7772 ***	3.21	1.2690 ***	13.11
Total earned income per capita, thousands SEK	22.3792 **	2.08	20.5942 *	1.93	26.9603 ***	2.88	25.7465 ***	2.66
Mortgage interest rate, percent	−0.2354	−1.55	−0.2125	−1.47	−0.2311 *	−1.73	−0.1334	−1.01
Construction costs per square meter for rental apartments	0.0520	0.06	0.0137	0.02				
Land costs per square meter for rental apartments	−0.4382	−1.38	−0.4329	−1.37				
Construction costs per square meter for cooperative apartments					1.1304	1.27	0.4551	0.52
Land costs per square meter for cooperative apartments					−0.8575 ***	−3.11	−0.7073 ***	−2.53

Table 5. *Cont.*

Variables	Model 2a. Dependent Variable: New Construction of Rental Apartments				Model 2b. Dependent Variable: New Construction of Housing Cooperatives			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z	Coefficient	t	Coefficient	z
Number obs.	47		47		47		47	
Number of groups	3		3		3		3	
R-squared: within	0.2966		0.2940		0.5365		0.5079	
between	0.9665		0.9697		0.9963		0.9960	
overall	0.6335		0.6359		0.8038		0.8389	
Hausman chi2	1.62				4.52			
Prob > chi2	0.9779				0.7187			

Note: *, **, *** denote statistical significance at the 10, 5 and 1% levels, respectively.

The results of the Hausman test justify that random effects regression provides more efficient estimates for the new construction of rental apartments and housing cooperatives. In both cases, the increase in population growth and change in total earned income have a positive effect on the new construction of housing dwellings. These effects are a bit higher for the housing cooperative sector (with a 1.2690% population growth and 25.7465% income growth in comparison with 0.7960% and 20.5942% for the rental sector). This implies that new construction in this sector is more elastic to changes in fundamental variables. Rent per square meter has a negative effect on the new construction for housing cooperatives and no significant effect on the new construction of rental apartments. Increase in the growth rate of the rent level decreases the new construction of housing cooperatives by 11.0016%. Estimation results for apartment price per square meter are not significant. Higher growth in land costs per square meter for newly built cooperative apartments has a negative effect on new construction in this sector, implying the importance of municipality land policies on the development of the housing market in larger metropolitan agglomerations. The R-squared value is 64% for rental apartments and 84% for housing cooperative apartments. It implies that the fundamental variables used in Models 2a and 2b might explain more than half of the variation of new dwellings construction.

Estimation results for model 3a, "Dynamics of dwelling conversions in the rental sector", and model 3b, "Dynamics of dwelling conversions in the housing cooperative sector", are presented in Table 6.

The results of the Hausman test indicate that for the rental sector, fixed effects regression provides more consistent estimators, while for housing conversions, random effect regression is more efficient. For the netto of dwelling conversions, only the growth of rent level per square meter provided a significant and negative estimator, implying that rent plays a major role for housing conversions. A higher rent level decreases the conversions to rental apartments by −15.0121%. A negative sign of this effect is unexpected but might still be explained by driving forces from demand side of the market—higher rent growth might decrease the tenants' demand for rental apartments if tenants cannot afford higher rent levels. It might also be an indicator of the rent control effect that exists in the housing market in Sweden. Companies might prefer not to do these conversions due to higher rent levels for other types of premises and more profitable conversions to housing condominiums. This is confirmed by the positive and significant impact of apartment price growth on the netto of dwelling conversions to housing cooperatives. A 1% higher growth in apartment prices increases the conversions to housing cooperatives by 4.9820%. It is interesting to observe that the impact of population growth is almost twice as high for dwelling conversions to rental apartments than for housing condominiums. Higher population growth might be a result of higher migration flows to major Swedish cities and more rapid urbanization processes in Sweden during the last two decades. However, according to banking regulations, the purchase of new apartments in Sweden requires a down payment that equals 15% of the market price—an amount that not all inhabitants new to the city can afford. Therefore, the effect on conversions to rental apartments coming from population growth is higher than the effect on conversions to housing cooperatives.

R-squared, however, was very small, implying that the interconnection between the netto of dwelling conversions in the rental sector and fundamentals is very weak or almost zero. R-squared for the netto of dwelling conversions to housing condominiums is 42%.

Table 6. Dynamics of dwelling conversions.

Variables	Model 3a. Dependent Variable: Netto of Dwelling Conversions to Rental Apartments				Model 3b. Dependent Variable: Netto of Dwelling Conversions to Housing Cooperative Apartments			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z	Coefficient	t	Coefficient	z
Cost	5.2325	0.99	−15.0121 ***	−5.69	4.1389	0.90	−2.6907	−1.40
Rent per square meter, SEK	−15.3914 *	−1.93	−23.6998 **	−2.55	−7.5585	−1.09	−10.4554	−1.54
Apartment price per square meter, SEK	−1.1318	−0.59	1.2190	0.55	4.1819 **	2.51	4.9820 ***	3.06
Population growth, inhabitants	−0.1352	−0.24	2.0037 ***	7.38	0.1874	0.39	0.9087 ***	4.58
Total earned income per capita, thousands SEK	29.3052	1.28	23.9163	0.88	−13.8602	−0.70	−15.4924	−0.78
Mortgage interest rate, percent	−0.3331	−1.04	0.0537	0.15	0.1496	0.54	0.2795	1.04
Number obs.	47		47		47		47	
Number of groups	3		3		3		3	
R-squared: within	0.1239		0.0314		0.1987		0.1658	
between	0.4979		0.9780		0.9866		0.9821	
overall	0.0042		0.5999		0.2465		0.4211	
Hausman chi2	18.93				7.46			
Prob > chi2	0.0020				0.1889			

Note: *, **, *** denotes statistical significance at the 10, 5 and 1% level, respectively.

Estimation results for model 4a, "Displacement effects for new construction in the rental sector", and model 4b, "Displacement effects for new construction in the housing cooperative sector", are presented in Table 7.

The R-squared values in models for the rental and housing cooperative sector equal 95 and 96%, respectively. The random effects model provides more efficient estimators for both sectors in comparison with the fixed effect model. The coefficients σ_1 and σ_2 for the rental and housing cooperatives sectors are very close to each other and equal 0.7779 and 0.7581. It implies that we do not observe displacement effects from either sector for the total new construction of housing dwellings in major Swedish cities. An increase in growth rate of rent per square meter decreases the new construction of rental dwellings by 2.8911%. This is opposite to what was expected. It indicates that despite the growth of rent level, the new construction of rental apartments is decreasing. It might be evidence of the rent control effect on the behavior of the property developers from the supply side and also a shift down in demand from tenants, since the rent level might be already high and unaffordable, thus leading to the shift down in the demand curve. An increase in the population growth rate by one percentage point will increase the new construction of rental apartments by 0.4136%. Estimations for fundamental variables for the housing cooperative sector appear to be insignificant. The insignificant estimators of land costs might indicate that land policies do not have an impact on the level of new residential construction in both sectors.

Table 7. Displacement effects for new apartments construction.

Variables	Model 4a. Dependent Variable: Total New Construction of Rental Apartments				Model 4b. Dependent Variable: Total New Construction of Housing Cooperatives			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z	Coefficient	t	Coefficient	z
Cost	−0.2832	−0.29	−1.6767 ***	−3.95	1.75 *	1.73	1.7071 ***	3.16
New construction of rental apartments, dwellings	0.7970 ***	12.39	0.7779 ***	11.75				
New construction of housing cooperative apartments, dwellings					0.7776 ***	10.71	0.7581 ***	10.92
Rent per square meter, SEK	−1.9214	−1.29	−2.8911 *	−1.91	0.5772	0.36	0.8100	0.50
Apartment price per square meter, SEK	−0.5809	−1.65	−0.3982	−1.12	0.3369	0.82	0.2683	0.71
Population growth, inhabitants	0.2538 **	2.27	0.4136 ***	6.07	0.0472	0.39	0.0679	0.70
Total earned income per capita, thousands SEK	6.6818	1.50	7.4555	1.62	3.0994	0.68	2.7595	0.60
Mortgage interest rate, percent	−0.0402	−0.66	−0.0192	−0.31	−0.0753	−1.23	−0.0767	−1.33
Construction costs per square meter for rental apartments	−0.0761	−0.24	−0.1664	−0.50				
Land costs per square meter for rental apartments	0.0278	0.22	0.0281	0.21				
Construction costs per square meter for cooperative apartments					−0.0125	−0.03	0.0245	0.06
Land costs per square meter for cooperative apartments					−0.1782	−1.30	−0.1998	−1.53
Number obs.	47		47		47		47	
Number of groups	3		3		3		3	
R-squared: within	0.8859		0.8799		0.8859		0.8853	
between	0.9902		0.9938		0.9931		0.9937	
overall	0.9490		0.9543		0.9565		0.9567	
Hausman chi2	5.6				3.78			
Prob > chi2	0.0609				0.1507			

Note: *, **, *** denotes statistical significance at the 10, 5 and 1% level, respectively.

Estimation results for model 5a, "Displacement effects for dwelling conversions in the rental sector", and model 5b, "Displacement effects for dwelling conversions in the housing cooperative sector", are presented in Table 8.

The R-squared values for dwelling conversions equal 78% for the rental sector and 94% for the housing cooperative sector. The random effect model is more efficient for the rental sector, and the fixed effect model provides more consistent estimators for the housing cooperative sector.

Growth in apartment prices has a positive and significant effect on the number of dwelling conversions to rental apartments of 3.5051%. At the same time, it has a negative effect of 0.7636% for the housing cooperative sector. This implies that the growth rate of apartment prices might be too high and that the demand for added apartments through conversions from other sectors and between sectors flows more toward the rental sector. A higher growth in the mortgage interest rate decreases conversions to housing cooperatives by 0.1273%.

The coefficients φ_1 and φ_2 for the rental and housing cooperative sectors are 0.5233 and 0.9059, respectively. This implies that there are no crowding-out effects for the total number of housing conversions from either the rental or housing cooperative sector. Since the coefficient φ_2 is almost twice as high as the coefficient φ_2, it implies that conversions to housing cooperatives demonstrate a filling-in effect (dominant effect) over the conversions to rental apartments.

Table 8. Displacement effects for dwelling conversions.

Variables	Model 5a. Dependent Variable: Total Netto of Dwelling Conversions to Apartments				Model 5b. Dependent Variable: Total Netto of Dwelling Conversions to Apartments			
	Fixed Effects		Random Effects		Fixed Effects		Random Effects	
	Coefficient	t	Coefficient	z	Coefficient	t	Coefficient	z
Cost	1.6366	0.51	2.6387	1.53	0.7678	0.70	−2.6867 ***	−5.22
Netto of dwelling conversions to rental apartments, dwellings	0.5505 ***	5.72	0.5233 ***	6.84				
Netto of dwelling conversions to housing cooperative apartments, dwellings					0.9059 ***	23.96	0.9402 ***	23.09
Rent per square meter, SEK	−0.3054	−0.06	−0.2100	−0.04	−1.9317	−1.17	−2.7808	−1.53
Apartment price per square meter, SEK	3.6479 ***	3.13	3.5051 ***	3.21	−0.7636 *	−1.80	−0.5411	−1.15
Population growth, inhabitants	0.2426	0.72	0.1487	0.73	−0.0016	−0.01	0.3428 ***	5.39
Total earned income per capita, thousands SEK	−21.4275	−1.53	−20.7208	−1.55	7.2624	1.55	6.3595	1.22
Mortgage interest rate, percent	0.1916	0.98	0.1671	0.93	−0.1273 *	−1.94	−0.0676	−0.95
Number obs.	47		47		47		47	
Number of groups	3		3				3	
R-squared: within	0.5599		0.5588		0.9491		0.9377	
between	0.9995		0.9990		0.9974		1.0000	
overall	0.7813		0.7826		0.9399		0.9671	
Hausman chi2	0.24				12.66			
Prob > chi2	0.9997				0.0488			

Note: *, *** denotes statistical significance at the 10% and 1% level, respectively.

6. Discussion

In order to examine the long-term dynamics of new residential supply in Sweden, we estimated the relationship between the new construction of apartments and market fundamentals as well as the impact of municipal land policies and housing policies on property conversions. We do not provide a comparison of estimations made in previous studies in this section since, as indicated in Table A1 in Appendix A, the major dependent variables are expressed as new constructions of single-family housing, housing starts or construction permits, which is not directly comparable with the dependent variables used in our models.

6.1. Role of Market Fundamentals

The rapid urbanization process that occurs in many countries includes three major Swedish cities (Stockholm, Gothenburg and Malmo). Higher employment and population growth results in a higher demand for housing, which results in continuous house price growth and longer waiting times for rental housing.

Municipalities have provided extensive subsidies to housing producers and property owners over the past two decades. Supply-side subsidies include lower land prices to increase the supply of rental housing units and decisions on mortgage interest rates for income tax purposes for homeowners. Lower land prices intended to increase the new construction of rental apartments. Subsidies on mortgage interest rates increase demand for housing through price mechanisms, which in turn should stimulate the new housing construction of housing cooperatives. However, the impact on construction depends on the price elasticity of supply. The results of our study indicate that new housing supply is not price elastic and mainly depends on other market fundamentals such as population and income growth and a decrease in mortgage interest rates. Construction costs do not have an effect on the size of new construction in both sectors. Rent growth has a negative impact on new construction in the housing cooperative sector and no effect on the new construction of rental apartments. This might be explained by the existence of rent control policies in the Swedish housing market. However, we have not found evidence of the displacement mechanisms in new construction between the rental and housing cooperative sectors (model 4), which implies that new construction in both sectors contributes to long-run housing market dynamics in a similar way.

6.2. The Role of Municipal Land Policies

The results of estimations in models 1–2 indicate that higher land costs decrease the new construction of housing cooperative apartments and decrease the growth of the total housing stock. At the same time, the effect of land costs for rental apartments was insignificant, which implies that we were unable to provide evidence that municipal land policies lead to an increase in the new construction of rental dwellings in the long run.

6.3. The Role of Policies on Property Conversions

As seen from models 3 and 5, the major way the structure of the housing market is changing in Sweden is through the dwelling conversion decisions of tenants and public property owners. Their investment decisions adjust housing supply to changing market conditions. These housing policies implemented in Sweden since the 1990s have helped many people become homeowners over the last two decades.

The major assumption in housing economics is that property owners maximize the value of the net benefits from the property. For tenants that are becoming members of the housing cooperatives, the benefits include housing consumption in a form of housing services and the return on housing investment in the form of capital gains when the apartment is sold. It is important to note that these investment decisions occur independent of income (as a fundamental variable in models 3a, 3b, 5a and 5b), implying that this process is mainly based on house price adjustments that are driven by low elasticity of housing supply and not fundamentals from the demand side of the market.

Rent control in the housing sector is another major factor for property conversions. With market rents, there will no market forces to convert rental apartments and other types of properties such as offices or industrial premises to housing cooperatives. Instead, market rents would stimulate the housing supply of rental dwellings as an alternative to other housing tenure forms such as housing cooperatives and condominiums and would press the house prices down over the long run, making housing more affordable to different population groups.

6.4. Impact on Housing Market Dynamics

As a result of the liberalization policies implemented in the 1990s in Sweden, we can observe two major effects in housing market dynamics—a decline of the rental housing sector and growth of the housing cooperative sectors. This is accompanied by the growth of house prices supported by a low interest rates environment.

If these trends will sustain in the future, the result over the long run might be that a majority of the urban population will find themselves living in expensive tenant-owned apartments, while the renting sector will decline and waiting time in queues for rental accommodation will increase.

Rental housing is important for young people entering the housing market, elderly households that do not need large housing due to a decrease in household size with time when children move out, and single parents with children who are looking for apartments after separation and might not have enough savings for the down payment needed to buy a housing cooperative apartment. Rental housing is also important for low/income households that might not be able to pay high rents.

7. Conclusions and Policy Implications

Econometric results indicate that the growth of the total housing stock, as tested in three major Swedish cities, occurs through new construction and dwelling conversions into owner-occupied apartments. The impact for the majority of fundamental variables lies in line with theory and previous studies and provides evidence of the interplay of the market forces of demand and supply.

The work outlined in this article allows us to draw the following conclusions:

- The major driving factors of new construction are income and population growth.
- Change in price, as one of the major determinants of housing supply, does not appear to be statistically significant in determining the size of new construction.
- Insignificant results for land costs for new construction in the rental sector indicates that we are unable to provide evidence of the effects of local municipalities' land policies to stimulate the new construction of rental apartments.
- We have not found a considerable difference in new construction with respect to property tenures. New construction of different types of housing tenures (rental and housing cooperatives) does not crowd out other types of new construction of multifamily dwellings.
- Our results suggest that mortgage interest rates do not stimulate more production of housing cooperative apartments than rental ones but do stimulate more property conversions to housing cooperative apartments. The low interest rate environment that Sweden experienced over the last two decades makes monthly payments for housing loans affordable to tenants in comparison to monthly rental payments they might pay. This makes the rental apartments they live in an attractive investment alternative, especially when considering the persistent growth in house prices that has occurred in Sweden since the 1990s.
- The importance of other fundamentals such as rent level is difficult to explain. It either has no or a negative impact on the size of the new construction and conversions to rental apartments and the total change in housing stock.
- Home renters are more likely to improve their housing by building housing cooperatives instead of buying apartments in new constructions. The apartment price per square meter in relation to rent level is the major driving factor in this process. We clearly see a displacement effect that occurs through dwelling conversions to housing cooperatives. One property unit converted to a housing cooperative dwelling almost doubles the total netto of dwelling conversions to housing, while at the same time, one property unit converted to a rental dwelling adds one unit to the total netto of dwelling conversions to housing.

In addition, it is important to mention that much of the research conducted on new supply is focused on the new supply of single-family owner-occupied housing and multifamily housing as housing cooperatives. We know much less about the determinants of the new supply of multifamily rental housing. Understanding these housing market dynamics is crucial for formulating future housing policies. We need to know more about the decision-making process of builders, investors and landlords, as they are important actors that determine housing supply in the rental sector as well as the renovation and conversion decisions of the property companies. Therefore, future research directions should lie in bringing new data on decision-making processes by local suppliers and municipal policies that can improve rental housing construction in efficient way.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Overview of the research literature on new housing supply.

Authors and Year of Publication	Country/ City	Type of Housing in Analysis	Years of Analysis	Method of Analysis	Dependent Variable	Independent Variable	Sign of Effect
DiPasquale & Wheaton (1994)	United States	Single-family housing starts	1963–1990	OLS regression	New construction of single-family houses	Current house prices Real costs of short-term construction financing Cost index for construction Cost index for land Stock of housing Current change of employment The number of months on the market for new homes recently sold Price series for new homes	+ (not significant)– + (not significant) - (not significant) - (not significant) + – +
Mayer & Somerville (2000)	United States	Single-family houses	1975–1994	OLS regression	Housing starts in a form of supply of developed lots	Change in price Change in price (t − 1) Change in price (t − 2) Change in price (t − 3) Change in real prime rate Change in real prime rate (t − 1) Stock (t − 1) Median month on market until sold-New homes (t − 1) Change in real building material costs	+ + + + – – + – –
Riddel (2004)	United States	Owner occupied single-family units	1964–1999	Augmented least squared regression	Supply model: Stock of residential units	Price index Rate on 3-month treasury bills GDP Apartment vacancy Construction cost index	+ - (not significant) + – - (not significant)
Riddel (2004)	United States	Owner occupied single-family units	1967–1998	SUR	Change in stock	Disequilibrium from the demand side Disequilibrium from the supply side Change in price Change in rent Change in vacancy rate Change in vacancy rate (t − 1) Change in price (t − 2) Change in treasury bill (t − 1) Change in treasury bill (t − 2)	- (not significant) – - (not significant) – - (not significant) + + - (not significant) –
Wigren & Wilhelmsson (2007)	12 West-European coun-tries	Number of residential dwellings	1976–1999	Panel data analysis	Supply in a number of dwellings	Construction price Property price Interest rate Consumer Price Index Price level GDP	– + – + + +
Ball et al. (2010)	Great Britain, United States and Aus-tralia	Private housing starts	1969–2007, 1970–2007, 1983–2008	SUR 2 step, OLS regression	Housing starts	Log of housing stock Lagged changes in log of real house price Changes in short-term interest rate Changes in log of construction costs	+ + – –

Table A1. *Cont.*

Authors and Year of Publication	Country/ City	Type of Housing in Analysis	Years of Analysis	Method of Analysis	Dependent Variable	Independent Variable	Sign of Effect
Warsame et al. (2010)	All regions in Sweden	Single- and multifamily houses	1976–2006	Instrumental variable (IV) and seemingly unrelated regressions (SUR)	Total production of single- and multifamily houses	Real production costs Real income per capita Stock per capita Interest subsidy Construction taxes Interest rate Population	−/+ /+ −/+ −/+ −/+ −/+ −/+
Lerbs (2014)	Germany, 413 counties and cities	Single-family houses	2004–2010	Dynamic panel data analysis	Construction permits	Permit rate (t − 1) House price–construction costs ratio Spatial lag of house-price construction costs ratio Land price Time effects	+ + + − −
Owusu-Ansah (2014)	United Kingdom, Aberdeen	Single-family houses	1986–2010	OLS regression	Private single-family housing starts	Lagged housing stock Property price index rate of change Material costs index rate of change Interest rate Time on the market Building warrant granted to approved ratio	+ + −/+ (not significant) - (not significant) − +
Stevenson & Young (2014)	Ireland	Private housing completions	1978–2008	Multiple error-correction model	Housing completions	Real new house prices Real building costs Real after tax interest rate Time effects	+ − - (not significant) −

Table A2. Variables definitions and data sources.

Variable	Definition	Unit	Data sources
New construction of rental apartments	New construction of rental apartments	Dwellings	National Statistical Bureau SCB Sweden
New construction of housing cooperative apartments	New construction of housing cooperative apartments	Dwellings	National Statistical Bureau SCB Sweden
Netto of conversions to rental apartments	Netto of conversions to rental apartments	Dwellings	National Statistical Bureau SCB Sweden
Netto of conversions to housing cooperative apartments	Netto of conversions to housing cooperative apartments	Dwellings	National Statistical Bureau SCB Sweden
Rental apartment stock	Rental apartments stock (existing and new construction)	Dwellings	National Statistical Bureau SCB Sweden
Housing cooperative apartment stock	Housing cooperative apartments stock (existing and new construction)	Dwellings	National Statistical Bureau SCB Sweden
Total apartment stock in multifamily buildings	Total apartments stock (existing and new construction)	Dwellings	National Statistical Bureau SCB Sweden
Rent per square meter	Rent per square meter in existing stock	SEK	National Statistical Bureau SCB Sweden
Apartment price per square meter	Apartment price per square meter in existing stock	SEK	Mäklarstatistik Sweden
Population	Total number of inhabitants	Inhabitants	National Statistical Bureau SCB Sweden
Population growth	Growth of the total number of inhabitants	Inhabitants	National Statistical Bureau SCB Sweden
Total earned income per capita	Total earned income of private persons	Thousands SEK	National Statistical Bureau SCB Sweden
Mortgage interest rate	Interest rate for mortgage borrowing	Percent	Central Bank of Sweden and Swedbank Sweden

Table A2. *Cont.*

Variable	Definition	Unit	Data sources
Construction costs per square meter for newly built rental apartments	Construction costs per square meter for new construction of rental apartments	SEK	National Statistical Bureau SCB Sweden
Land costs per square meter for newly built rental apartments	Land costs per square meter for new construction of rental apartments	SEK	National Statistical Bureau SCB Sweden
Construction costs per square meter for newly built cooperative apartments	Construction costs per square meter for new construction of cooperative apartments	SEK	National Statistical Bureau SCB Sweden
Land costs per square meter for newly built cooperative apartments	Land costs per square meter for new construction of cooperative apartments	SEK	National Statistical Bureau SCB Sweden

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Table A3. Stationarity test for variables.

Variables	Level		First Difference	
	t	*p*	t	*p*
New construction of rental apartments, dwellings	−4.8686 ***	0.0000	−10.4048 ***	0.0000
New construction of housing cooperative apartments, dwellings	−4.3045 ***	0.0000	−8.6867 ***	0.0000
Netto of conversions to rental apartments, dwellings	−5.7540 ***	0.0000	−8.4685 ***	0.0000
Netto of conversions to housing cooperative apartments, dwellings	−3.5332 ***	0.0005	−6.5882 ***	0.0000
Rental apartment stock, dwellings	−0.2504	0.9954	−3.0614 ***	0.0046
Housing cooperatives apartment stock, dwellings	−1.0147	0.8316	−2.4092 **	0.0446
Total apartment stock in multifamily buildings, dwellings	−0.2514	0.9956	−3.4299 ***	0.0007
Rent per square meter, SEK	−1.6756	0.5043	−4.0411 ***	0.0004
Apartment price per square meter, SEK	−1.9289	0.2290	−3.7516 ***	0.0003
Population, number of inhabitants	−0.2063	0.9968	−2.1576	0.1050
Population growth, number of inhabitants	−2.5685 **	0.0293	−4.6846 ***	0.0000

Table A3. *Cont.*

Variables	Level		First Difference	
	t	*p*	t	*p*
Total earned income per capita, thousands SEK	−1.6432	0.3667	−3.7455 ***	0.0002
Mortgage interest rate, percent	−1.4394	0.5112	−6.3066 ***	0.0007

Note: The IPS test is based on the individual ADF regressions with an intercept, trend, and first lag of the dependent variable. The test statistic has an asymptotic standardized normal distribution. ** denotes rejection of the null hypothesis of unit root based on their *p*-value at the 0.05 significance level. *** denotes rejection of the null hypothesis of unit root based on their *p*-value at the 0.01 significance level.

Table A4. Results of the VIF tests on variables in model 1.

Variables	VIF	Tolerance
Total stock of multifamily dwellings, number of dwellings	1.50	0.6649
Rent per square meter, SEK	1.92	0.5198
Apartment price per square meter, SEK	1.48	0.6775
Population growth, number of inhabitants	1.10	0.9102
Total earned income per capita, thousands SEK	5.05	0.1980
Mortgage interest rate, percent	4.10	0.2441
Construction costs per square meter for newly built rental apartments, SEK	2.10	0.4163
Land costs per square meter for newly built rental apartments, SEK	2.91	0.3442
Construction costs per square meter for newly built cooperative apartments, SEK	2.31	0.4337
Land costs per square meter for newly built cooperative apartments, SEK	2.58	0.3882

Table A5. Results of the VIF tests on variables in models 2a and 2b.

Variables	Model 2a. For Rental Apartments		Model 2b. For Housing Cooperatives	
	VIF	Tolerance	VIF	Tolerance
New construction of dwellings, number of dwellings	2.75	0.3641	6.21	0.1611
Rent per square meter, SEK	1.83	0.5479	2.24	0.4461
Apartment price per square meter, SEK	1.13	0.8830	1.33	0.7522
Population growth, number of inhabitants	2.64	0.3795	5.70	0.1755
Total earned income per capita, thousands SEK	4.73	0.2115	4.90	0.2040
Mortgage interest rate, percent	3.65	0.2737	3.41	0.2934
Construction costs per square meter for newly built rental apartments, SEK	1.74	0.5763		
Land costs per square meter for newly built rental apartments, SEK	1.82	0.5502		
Construction costs per square meter for newly built cooperative apartments, SEK			1.47	0.6783
Land costs per square meter for newly built cooperative apartments, SEK			1.47	0.6813

Table A6. Results of the VIF tests on variables in models 3a and 3b.

Variables	Model 3a. For Rental Apartments		Model 3b. For Housing Cooperatives	
	VIF	Tolerance	VIF	Tolerance
Netto of dwelling conversions, number of dwellings	2.50	0.4001	1.73	0.5789
Rent per square meter, SEK	2.01	0.4971	1.84	0.5445
Apartment price per square meter, SEK	1.12	0.8936	1.37	0.7326
Population growth, number of inhabitants	2.45	0.4079	1.59	0.6283
Total earned income per capita, thousands SEK	4.20	0.2379	4.19	0.2389
Mortgage interest rate, percent	3.29	0.3039	3.38	0.2962

Table A7. Results of the VIF tests on variables in models 4a and 4b.

Variables	Model 4a. For Rental Apartments		Model 4b. For Housing Cooperatives	
	VIF	Tolerance	VIF	Tolerance
Total new construction of dwellings in multifamily housing, number of dwellings	21.88	0.0457	23.09	0.0433
New construction of rental apartments, number of dwellings	12.72	0.0786		
New construction of housing cooperative apartments, number of dwellings			25.70	0.0389
Rent per square meter, SEK	2.00	0.4998	2.26	0.4432
Apartment price per square meter, SEK	1.17	0.8549	1.35	0.7423
Population growth, number of inhabitants	5.19	0.1927	5.77	0.1733
Total earned income per capita, thousands SEK	5.05	0.1979	4.95	0.2021
Mortgage interest rate, percent	3.66	0.2730	3.57	0.2804
Construction costs per square meter for newly built rental apartments, SEK	1.75	0.5725		
Land costs per square meter for newly built rental apartments, SEK	1.82	0.5495		
Construction costs per square meter for newly built cooperative apartments, SEK			1.47	0.6782
Land costs per square meter for newly built cooperative apartments, SEK			1.56	0.6419

Table A8. Results of the VIF tests on variables in models 5a and 5b.

Variables	Model 5a. For Rental Apartments		Model 5b. For Housing Cooperatives	
	VIF	Tolerance	VIF	Tolerance
Total netto of dwelling conversions, number of dwellings	4.60	0.2174	30.36	0.0329
Netto of dwelling conversions to rental apartments, number of dwellings	5.43	0.1843		
Netto of dwelling conversions to housing cooperative apartments, number of dwellings			24.75	0.0404
Rent per square meter, SEK	2.01	0.4971	1.94	0.5145
Apartment price per square meter, SEK	1.41	0.7110	1.41	0.7091
Population growth, number of inhabitants	2.48	0.4025	2.75	0.3640
Total earned income per capita, thousands SEK	4.45	0.2245	4.34	0.2303
Mortgage interest rate, percent	3.36	0.2975	3.45	0.2896

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