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Apartment Allocation in a Price Regulated Queue Market

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Abstract

The issue of a housing shortage is a focal point of Swedish political debate, often in relation to the rental regulation present. This thesis focuses on egalitarianism and self-segregation using a data set covering intermediated rental apartments from the Stockholm Housing Agency 2006–2015. We analyse the allocation of apartment value in a straight queue with partial market rents. The market prices of adjacent housing co-operatives are used to estimate a value for each rental apartment. We then examine how the value is distributed and use the average area income per postal code to show if there is evidence of self-segregation. Our analysis indicates that the rent and queue time are the main factors determining the allocation of apartment value in the housing queue. The regulation gains, estimated by assuming a cost of capital and comparing market value to actual rents, are distributed proportionally to rent and hence to income. Consequently, the allocation is more egalitarian than a pure market, but allocates the greatest gains to the highest income groups. We find weak evidence of self-segregation using average area income and ambiguous results with other measures. The study indicates an efficient allocation with regard to queue time and rent, although there is reason to nuance the egalitarian picture of the rental regulation.

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1 Introduction

There is growing concern among policymakers and the public alike over the shortcomings of the Swedish housing market. Rental apartments are often considered part of the solution, requiring less capital than housing cooperatives or detached housing, and are argued to be more accessible to young people and socio-economically disadvantaged groups. In Sweden, rental apartments are subject to price regulation, due to a political ambition to make the access to housing more egalitarian. However, this leads to queues to rental apartments in attractive locations. There is debate over the economic consequences of the rent control, where some claim it counteracts segregation, while the vast majority of research and economic theory indicates substantial societal losses (Andersson & Söderberg, 2012).

In this thesis we aim to analyse the mechanisms affecting the outcome of the Swedish rental regulation with a focus on the distributional outcomes. In Stockholm, the municipality has developed a housing agency for the intermediation of rental apartments in the Stockholm region. Our data covers the past ten years of the queue, encompassing information about all the allocated apartments and their new tenants. The allocation of apartments is mainly done by letting the members of the queue state their preferences and then distributing the apartments on the basis of queue time, after which receivers are moved to the end of the queue. Hence, the time spent in the queue is analogous to currency that accumulates over time. Given this, we will examine the extent to which the outcomes are egalitarian, market-based or a product of self-segregation. This will be carried out by analysing the impact of queue time, rent, income and how the regulation gains are distributed.

In Section 2 we examine the objectives of the Swedish housing policy and the rules and function of the rental regulation and queue. In Section 3 we provide a literature review on spatial segregation. In Section 4 we provide an outline for our empirical research. In Section 5 we explain our method, data and variables used in detail. In Section 6 we present our results, which are then discussed in Section 7. Section 8 provides a brief conclusion followed by references and an Appendix.

2 Background

2.1 A review of housing policy in Sweden

Swedish housing policy has long been characterised by government intervention and high social ambitions. In this section, we examine its objectives in a historical and political context, both with reference to the situation in Stockholm and on a national level.

Housing shortages have been a reoccurring feature of Stockholm's 20th century history. The market has been seen as an insufficient provider of housing, distributing vastly superior housing to wealthy people and hence creating undesired inequality, warranting government intervention. It has also been argued that the market alone cannot reach an equilibrium providing sufficient housing due to a low willingness among private constructors to invest. The main solution to housing shortages has therefore been considered to let the government increase the supply of housing, to permanently remove the shortage (Hedenmo & von Platen, 2007). Putting these issues into a historical context and understanding the objectives of Swedish housing policy is essential to understand the outcomes of the regulation and the segregation issue.

During the First World War the Swedish government introduced rent controls to stop increases in rents in the inflationary and unstable war economy. This regulation was removed shortly after the war. During the Second World War, the housing construction decreased heavily, pressuring the Swedish government to once again regulate the rents to limit inflation and social problems (Zetterberg, 1942). Afterwards, the government did not deregulate the housing market, as was done after the first war. Instead, the government developed a reform package with multiple regulations which constituted the foundation for today's housing policy in Sweden.

Before the end of the Second World War, the issue of housing had been associated with hygiene and health related problems. During the two wars it was generally discussed in the context of a shortage, but shifted after the Second World War to become an integral part of the Swedish welfare model. The government argued that the housing construction in a free market failed to respond to increased demand and that this created shortages which led to overcrowding and bad health.

During the long-term social democratic rule, public housing companies along with government subsidies directed towards building affordable housing have been the key elements of Swedish housing policy (Andersson & Turner Magnusson, 2014). Although varying in size and acuteness, housing shortages persisted until the construction of the large-scale modernist Million Programme in the late 60s and beginning of the 70s. About 100,000 apartments and single-family homes per year where built over ten years to facilitate the continuing rapid urbanisation and provide modern and spacious homes for everyone (Eriksson, 1994). This process mirrored the creation of the Swedish welfare model, often referred to as *Folkhemmet*.[1] One study identifies three distinct periods in the housing policy associated with *Folkhemmet*: the regulation, deregulation, and the return to market models (Grundström & Molina, 2016). Today, private provision of housing is the norm and newly constructed apartments are evenly divided between rentals and housing co-operatives, but in Stockholm the latter dominate with 65 per cent in 2014. Tenant-owned apartments and villas are not price regulated, and their prices have been rising rapidly over the past decades. Today, the thought of an acute housing shortage is commonly accepted, especially in relation to the large numbers of refugees that have migrated to Sweden in recent years.

The frequent use of the term housing shortage, *bostadsbrist*, warrants a closer definition. Its meaning has shifted slightly over the years, not necessarily indicating that there are not enough homes, but rather that there are not enough homes of an acceptable standard. Largely, it has to be put in a political context, where it has often be used to motivate policy measures (Boverket, 2007).

[1] Literally *the People's Home*, an attempt to reduce economic inequality and create a public welfare model while retaining significant capitalist elements.

2.2 An overview of current rental regulation

Due to rapid inflation and economic instability rent controls were introduced in Sweden during the second world war. In 1968, a government initiative was made to deregulate the market, resulting in a internationally unique pricing model typical for the Swedish model where organisations for public housing companies negotiate the rent levels with the organisation for renters (Hyreslagstiftningssakkunniga, 1966)(Hyressättningsutredningen, 2004). The outcomes of these negotiations set a binding norm for the entire rental market, where two apartments of equivalent size and standard should have approximately the same rent, creating a utility value system (Zetterberg, 1942).

While allowing near market-clearing rents for new apartments, the regulation effectively puts a price ceiling on old apartments. The rents are not allowed to appreciate in the same pace as property prices, and consequently a large gap is created between the stipulated rents and market rents in attractive locations (Eriksson & Lind, 2005). In addition, according to traditional economic theory price regulation will lead to underinvestment in maintenance. However, in the Swedish system the opposite effect is also likely to occur, since standard improvements can justify rent increases that bear little relation to the actual cost (Lind, 2015). The resulting system is far from the market equilibrium, in line with a system aimed to address market failure and produce egalitarian outcomes.

Typically, rich people tend to lose from alternative allocations systems such as queues and rationing, while poor people gain, at least from a theoretical perspective (Sah, 1987). In a paper from 2011 David P. Sims states that over the decades that rent control has been practised there has been little empirical research on how it affects the allocation of housing. In addition, economic theory yields ambiguous results when attempting to predict the outcome. However, he argues that while the size of the impact is uncertain, there are three main consequences of the introduction of rent controls:

1. rent control will affect the length of the period the renter retains the contract;
2. it replaces the market rationing mechanism with some non-price determination allocation made by the landlords;
3. produces a reduction in the quality of housing affected by the control.

Today 85 per cent of Swedish municipalities have reported a shortage of rental apartments. The average queue time for a one room apartment is 32 months, where the counties of Stockholm, Uppsala, Halland and Norrbotten have the longest queue times. (Boverket, 2007)

2.2.1 The utility value system

The utility value system, *bruksvärdesystemet*, has been the model prescribed by the law for determining rents since its introduction five decades ago. Its function creates a de facto price regulation. The organisations representing housing companies and tenants collectively negotiate a rent increase, which provides a benchmark that is used to determine if the rent of each individual apartment is reasonable with regard to its standard, regulated in §55 kap.12 Jordabalken (1970:994). In practice this is conducted in two stages. First, equivalent apartments in the same urban area are identified in terms of size, modernity, interiors, location and other important criteria, which is regulated in §21 Hyresförhandlingslagen (1978:304)(Hyresrättsutredningen, 1981). The rents of these are then used to determine the rent of another apartment, in case the landlord and tenant disagree about the appropriate level of the rent. If the rent is significantly higher, the landlord is compelled by law to reduce it to the level of the comparable apartments. This limits the landlords' ability to raise rents to brutish levels and protects the right of the tenant to keep its apartment (Boverket, 2014).

The law mandates primary bargaining between the landlord and a renters' association concerning the terms and conditions in rental agreements. The landlord is forbidden to close an agreement with the individual renter before negotiating with a renters' association. The purpose of this arrangement is to ensure the rental associations' right to collective bargaining which is a deeply entrenched

model in the Swedish rental housing market (Boverket, 2014). To facilitate new construction, newly constructed apartments can be subject to a specific negotiation between housing companies and tenants' organisations, where the rent does not have to be equivalent to similar apartments in the area. The exception extends to 15 years and is called presumption rent, which is detailed in §55 12. kap JB.

2.3 The municipal housing queue

During the 1930s the lack of living space and overcrowded housing dominated the political debate in Stockholm. After the Second World War, in nexus with the rental regulation, the municipality of Stockholm started an intermediation agency for rental housing, Stockholms bostadsförmedling, in 1947. The allocation of rental apartments was made based on the applicants' specific housing needs until the 1990s when the system was replaced by a formalised queue. The landlords can now set minimum requirements for the applicant and anyone who meets the the requirements of the apartment is eligible to rent it (Bostadsförmedlingen, 2016a).

Today the queue in the Stockholm Housing Agency contains over half a million members. The average queue time to receive a normal apartment contract was ten and a half years in 2015 (Bostadsförmedlingen, n.d.-b). The requirements usually consist of a minimum income and rules regarding the source and security of it. Since the queue contains both private and municipality owned housing, the requirements vary between different housing companies. The private housing companies owners do not pay any fees to have their rental apartment intermediated by Bostadsförmedlingen (Bostadsförmedlingen, 2016b). The available contracts can be roughly divided into four categories: normal rental contract; short term contracts with a limited rental period; age restricted apartments dedicated to pensioners and youth; and student apartments.

To be able to participate in the queue a person needs to fulfill certain regiments. The person must have a Swedish citizenship or co-ordination number,[2] be at least 18 years of age or have a proven pregnancy and pay the annual fee of 210 SEK. The fee was instituted 2001 and was initially 375 SEK before being reduced. Before 2014 the receiver of a rental apartment had to pay an intermediation fee of 1000 SEK to the rental agency (*Förmedlingsavgiften tas bort hos Bostadsförmedlingen — Hem & Hyra*, n.d.).

The queue time is counted from the day you register your membership.[3] Upon receiving a permanent rental contract the receiver loses its place in the queue. Short-term contracts, age restricted apartments and student housings usually allow the members to keep their place in the queue. For a very limited amount of apartments, the housing agency applies a first-come first-serve policy. Accepting such an apartment does not entail losing one's place in the queue (Bostadsförmedlingen, n.d.-a). One brief study of the queue in Stockholm using a simple regression model found that rent per square metre, city district, type of house and apartment size predicted 55 per cent of the queue time necessary to receive a specific apartment (Wall, 2004).

[2]A co-ordination number is an identification for people who are not or have not been registered in Sweden. The co-ordination numbers allow public agencies and other functions in society are able to identify people even if they are not registered in Sweden.

[3]Registration is usually performed through the agency's website, but it can also be made by post or in person at the service office.

3 Literature Review

3.1 Ethnic segregation and self-segregation

With a system designed to produce egalitarian outcomes and cater to the provision of affordable housing to everyone, segregation becomes a natural topic. There are several ways of defining segregation. However, for the purposes of this thesis we consider the spatial aspect of segregation meaning that different social groups are unevenly distributed geographically. Segregation is a multifaceted process, involving income constraints, discrimination and social preferences, and arises as a consequence of both minority and majority behaviour. There is a large body of work on spatial segregation. Although subject to some criticism (White, 1983), the index of dissimilarity is a common measure of segregation, often in the context of racial segregation in the US. Applied in Stockholm and other Nordic capital cities, it indicates a significant amount of ethnic segregation, whereof 55 per cent can be explained by segmentation, i.e. the type of tenure (Skifter Andersen et al., 2015). Since the market naturally segregates with regard to income, factors beyond rent will be examined more closely. We use self-segregation in this thesis to refer to social preferences to segregate with regard to socio-economic factors, despite having the means to live in an area with higher incomes or an apartment with a higher value.

Many attempts have been made to understand the driving factors behind segregation, mainly in the context of racial diversity. In an American context, where it has been most studied, the main factor for racial segregation is often understood to be economic status. However, discrimination against minorities is also considered to be a significant factor (Clark, 1986). While the majority of moves from poor to non-poor areas can be explained by the traditional model of human capital/life-cycle needs and hence housing availability, African Americans have greater difficulties escaping poor areas even when controlling for socio-economic factors (South & Crowder, 1997). This is confirmed by a longitudinal study of immigrants' housing careers in Sweden. Despite controlling for professional careers and family composition, immigrants still have different housing patterns, marked by a greater propensity to live in rentals instead of owner-occupied homes (Magnusson Turner

& Hedman, 2014). In another report, a regression analysis indicates that 50–70 per cent of the ethnic segregation in major Swedish cities remains after controlling for socio-economic factors, and that it differs widely between countries of origin (Skans & Åslund, 2009). Simply providing equal work opportunities is hence insufficient to remove segregation. In the American housing market, there is evidence of racial discrimination concerning treatment of potential home buyers, even though the actual impact on segregation is difficult to quantify (Yinger, 1998). Hence, social segregation with regard to both income and ethnicity can be understood as a mix of factors, where some are exogenous and some endogenous.

But segregation should not only be understood as a consequence of the actions of under-privileged minorities. There is evidence of white avoidance in Stockholm, where native Swedes are significantly less likely to move to areas with large immigrant populations than others (Andersson, 2013). On a similar note, there is evidence of 'super-gentrification' in Stockholm, and other Swedish major cities, where groups with very high incomes cluster in small areas (Hedin et al., 2012). However, since prices are determined by those being willing to pay the most in a given area, their preferences are more likely to align with the areas considered the most attractive by the aggregate market demand.

3.2 Income segregation

The majority of the literature on segregation focuses on ethnicity and race, where the topic of self-segregation has been given particular attention. But even in ethnically homogeneous countries, segregation with regard to income and education is a reoccurring phenomenon, which is obvious in the urban structures of previously homogeneous countries in Europe. As early in the 70s, before the existence of substantial minorities in Sweden, it was an explicit goal of the Million Programme to provide a socio-economic integration in new housing. The policy, along with other efforts to combat segregation, was largely a failure (Andersson, Bråmå & Holmqvist, 2010).

A Master's thesis found that people living in rent controlled apartments in attractive

locations are more likely to have higher incomes, be born in Sweden and have Swedish parents. The study was conducted with register data on 292 representative households in Stockholm (Fridell & Brogren, 2007). Demographic data from Cambridge, Massachusetts and nearby communities from 1990 to 2000 provides evidence that rent control increases the minority populations in an area but also that it leads to increased segregation by income (Sims, 2011). There is also some evidence that parents with children under the age of 18 who divorce tend to continue to live close to each other (Stjernström & Strömgren, 2012). However, its implications for income segregation are unclear; providing an incentive to stay in the area, it should work to strengthen both low-income and high-income clustering.

3.3 The effect of income in a deregulated public sector

Recently, several areas of the traditional Swedish model have been deregulated. While still publicly funded, private actors are allowed run health care facilities and schools in exchange for standard reimbursements from the political entities responsible for the area in question. Everyone is allowed to choose whichever school or health care facility they want to certain extent. In this respect, it shares some similarities with the housing queue, since everyone pays the same amount in the case of health care and nothing in the case of schools, yet can choose between institutions of different quality. Similarly, the queue time is egalitarian in its universal accessibility, except with regard to age. In the context of this thesis, we use the term egalitarian to denote something which is equally accessible to everyone regardless of the financial means, which the housing queue satisfies apart from the 210 SEK annual fee. This, of course, does not necessarily lead to completely egalitarian outcomes, but in most cases constitutes an important prerequisite.

It has be shown that high-income groups are more likely to choose private health care and display greater satisfaction with the availability of care (Janlöv et al., n.d.). They also tend to use private care-givers to a higher degree, which along with being healthier leads to the risk of inequal health care (Myndigheten för vårdanalys, 2015). There is also evidence that the free choice of schools, *det fria skolvalet*, has accentuated segregation in the school system (Böhlmark, Holmlund & Lindahl,

2015). In the light of this, there seems to be evidence that a high income groups derive a greater benefit from the Swedish welfare system. In turn, this can be considered a form of self-segregation, perhaps due to an information advantage. Hopefully, our investigation can indicate if there are similar mechanisms at work in the housing queue.

In conclusion, segregation can be said to consist of three main processes. First, income constraints mean that low-income groups cannot afford to live in the most attractive areas. Second, there might be a component of discrimination, where landlords are less inclined to give housing to minorities or low-income groups. Third, which will be the aspect primarily analysed in this thesis, there are other factors at work. This might be a preference to live with similar ethnic or social groups, a lack of information on how to make optimal choices, or liquidity constraints forcing suboptimal choices.

4 Research design

4.1 Research question

Rental apartments represent a substantial share of the apartments in Stockholm, and with sharply increasing prices for co-operative apartments and a housing shortage, their allocation deserves ample attention. In this partially regulated market, we think that there are three central factors determining the allocation which are central to our analysis. These are the rent, queue time and income of the recipient of the apartment. By examining the impact of these factors on the allocation of apartment value, we hope to provide evidence on the extent of the system's egalitarianism and potential self-segregation from a new perspective.

The presence of queue time as a determining factor is the main difference from a normal market, where the exchange is determined by a supply and demand driven equilibrium price. Since it is equally available and very inexpensive, it is the key egalitarian factor. This is also the stated aim of its presence; to make housing in all parts of Stockholm available to as diverse social groups as possible.

The rent represents the remaining standard market mechanism. The extent to which it reflects the market value of the apartment indicates the degree of market rents. Since it is allowed to vary with size and standard, which usually are important factors of determining market value, we expect it to be of some importance.

And finally, the remaining individual preferences captured by income as a proxy for some other characteristics belonging to the applicant. In the studies examining segregation we have referred to, self-segregation is typically considered to be the residual segregation when other factors such as income have been accounted for. In the context of our study, we hence define as self-segregation as preferences resulting in suboptimal choices in relation to aggregate pricing mechanisms. This is made visible by the fact that the implicit value of queue time cannot be realised elsewhere, unlike money which is the usual currency of exchange. Its size will indicate the presence of some other factor affecting outcomes, perhaps different preferences due

to ethnicity, class or other circumstances. While this is likely to exist in all classes, the preferences of high-income groups are more likely to align what the aggregate market mechanism values the highest, since they are the ones able to spend the most money on housing.

Hence, the existence, non-existence and magnitude of these will enable us draw conclusions about the allocation of apartments in relation to topics of concern for housing policy. It will also provide some evidence on the role of individual preferences in the context of segregation, as opposed to income constraints and discrimination. As a natural part of this, we will also examine the distribution of the gains from the lower than market prices. We will thus test the hypotheses of three distinct ways of determining the allocation of apartments, which we believe the current system is likely to be a mix of:

- Non-egalitarian allocation:

$$H0_1 : \textit{The allocation of apartment value is not determined by queue time} \tag{1}$$

- Non-market allocation:

$$H0_2 : \textit{The allocation of apartment value is not determined by rent.} \tag{2}$$

- Non-segregation allocation:

$$H0_3 : \textit{The apartment allocation is not determined by income} \tag{3}$$

By testing these, we will be given an indication of how the system functions, and which aspects that need to be targeted if one wants to change the outcome in a given direction. It also, to an extent, contrasts competing perspectives on how housing is or ought to be distributed, ranging from political ambitions, market mechanisms, and sociological perspectives on segregation. The analysis is two-layered in the sense that we first examine the allocation of apartment value, and then the gains from the rental regulation, which we henceforth will denote as a subsidy.

4.2 Regression model

Our overarching aim is to try to evaluate the relative importance of our key factors in determining how apartment value is allocated and if there is reason to believe that the allocation is effected by self-segregation. We set up the following regressions where we try explain the value of apartments using queue time, income and control variables. If a coefficient is significant, we can reject the corresponding hypothesis.

$$Apartment\,value = \beta_0 + \beta_1(queue\,time) + \beta_2(rent) + \beta_3(income) + control\,variables \tag{4}$$

Where can then reject our hypotheses in the following cases:

$$H0_1 : \beta_1 \neq 0,\ H0_2 : \beta_2 \neq 0 \tag{5}$$

In addition, we will supplement apartment value with the average income of the area adjacent to the intermediated apartment in order to examine our third hypothesis. This provides a measure of the income group inhabiting the area.

$$Area\,income = \beta_0 + \beta_1(queue\,time) + \beta_2(rent) + \beta_3(income) + control\,variables \tag{6}$$

Where can then reject our hypotheses in the following case:

$$H0_3 : \beta_3 \neq 0 \tag{7}$$

We use a simple OLS regression with the estimated value of the apartment and average area income as our dependent variable. We choose this method because it provides a straight forward interpretation, and given our data and hypothesis it is likely to yield the most accurate results. Contingent on the fulfillment of the assumptions of the Gauss-Markov theorem, it is the best linear unbiased estimator. Its main assumptions are that the expected value of the standard errors is zero and homoscedasticity. Using robust standard errors, we can allow for some heteroscedasticity in the residuals. We also need to assume strict exogeneity. The low

number of observations per postal code per year precludes us from using yearly fixed effects, which is why we later adjust all rents, incomes and prices to account for changes until year 2015.

5 Method

5.1 Assigning value to the rental apartments

To be able to compare the pricing of apartments via queue time to that of an ordinary market, we need to estimate the value of the rental apartments intermediated. Estimating a value of the rental apartments is associated with certain difficulties. First, we cannot observe a market price for the rental apartments which makes us forced to rely on an estimation of the rental apartments value. This creates the second problem, to estimate the value of the rental apartment. Estimating a value for the rental apartments creates the third problem of determining what is a viable proxy for the market value of rental apartments. Since we can not observe a value of the rental apartments we will be forced to assume correlations that may in fact be false.

Still, in order to estimate a value of the rental apartments we argue that there are several available proxies for a rent controlled apartment. Later we will elaborate on this in more technical detail. First, we use the prices of apartments in the same areas. Second, we can use the subsidy value that is created as a result of the rental regulation. There are many reasons to believe that the rent controlled apartments have a lower rent than the market value. This can be estimated as a total subsidy in perpetuity, or as in our second case: as an annual subsidy.

5.1.1 Housing cooperatives as a way of estimating market value

Housing cooperatives provide the closest benchmark for the true value of rental contracts. Estimating the market value of rental apartments through owner apartments has previously been employed to calculate the price difference in a regulated market (Det Ökonomiske Råd, 2001). Given that we control for rent level and

apartment features such as size, the most important factor for the market value should be the location. In a perfect market this would be accounted for by rent differences, but since the rental regulation allows little variation of rent due to location, this is not the case. The only other significant form of apartment ownership in Sweden is housing co-operatives. Formally representing a share in an organisation owning the property, they are in practice traded as free apartments. The prices are freely set by the market and there is a well developed system for exchange. However, there are some limitations. Subletting is limited and transactions are subject to approval by the board, which in the latter case rarely poses a problem.

Given that we can assume that the market for housing co-operatives more accurately prices apartments than the rental market and that there are no significant systematic differences, we can use it as proxy. Since we cannot observe the standard of neither rental contracts nor co-operatives, we have to assume that the relation between the standard of co-operatives and rental housing is similar across areas. For example, the standard of co-operatives should relate in the same way to rental housing in Östermalm (high-income inner-city) as in Rinkeby (low-income *banlieue*-like). There are arguably at least two factors at work. The stringent demands on the housing standard of rental apartments is likely to create a high minimum standard and the utility value system in itself incentivises renovation (Lind, 2015). Simultaneously, there are greater private incentives to raise the standard of co-operatives, where the marginal product of capital investments increases with rising property prices. The first is likely to affect areas in a similar way since most landlords have incentives to increase rents in the presence of a housing shortage. The second, however, might have a greater effect in areas with high property prices, in which case valuing the rentals using co-operatives would be distorted. However, this depends on the magnitude of the apartment standard's effect on price.

5.1.2 Subsidy value as a measure of system gain

We have presented a straight forward measure to examine the allocation of rental apartments — estimated market prices. Although we think that the market value

of nearby co-operative apartments provides an accurate estimate for the value for the rental apartments, we would like to enhance that estimate even further. An artificial price ceiling gives a lower cost for those who live in a rental apartment compared to those who lives in a co-operative apartment. Hence, the subsidy value can be defined as the difference between the cost of an co-operative apartment (estimated market value and the net present value of the upkeep fee) and the net present value of the rent. In order for this to be completely accurate, with have to assume that rental apartments and co-operatives do not differ systematically in standard. By analysing this, we can see what explains who receives the greatest gain from the rental regulation.

5.1.3 Average income as a measure of segregation

The mean income in the area the apartment is located in gives a direct picture of the incomes of people in a given neighbourhood. By using this, we are able to directly examine how the inflow of renters relates to the incomes of those presently living in the neighbourhood. This is likely to correlate heavily with apartments prices, but if it is the case the self-segregation exists due to a preference to live with similar income groups, it provides a more adequate measure.

5.2 Data description

We will first present the scope and range of the data sets and discuss potential problems with the data sets and how those problems are addressed. Secondly, we describe limitations and missing data due to incomplete observations and its implications for our analysis.

Our primary data set contains ordinary apartments that have been intermediated through the ordinary housing queue at the Stockholm Housing Agency and includes a cross-sectional data of about 40,000 of normally intermediated standard rental apartments during the period from 2 January 2006 to 31 December 2015. This excludes short-term contracts, student apartments, senior apartments and other apartments.

All apartments lie within Stockholm County and it includes apartments in other municipalities than the city of Stockholm. We use postal codes as the geographical unit for comparison. The areas are quite small and focused, unlike other possible units like streets or entire neighbourhoods, while providing an official area with a clear definition that is suitable for comparison.

To get postal codes for every apartment address we used Google Maps API. Drawing its data from reliable sources, we have reason to believe it is correct.[4] However, in the case two identical addresses exist in Stockholm County, we were unable to retrieve the postal code. In the case of co-operatives, this amounts to about 1,800 apartments.

5.3 Variable description

In this section we divide our variables into three parts: those who are dependent, independent of major interest and control variables. We conduct two separate tests with the estimated value for co-operative apartments in the same area as a independent variable in the first test and the average area income in the second.

5.3.1 Dependent variables

Value based on housing cooperatives. By pooling the co-operative apartments we generated an average price per square metre for each postal code. If buyers of apartments have fully informed rational expectations of the future market prices, using the prices without accounting for yearly differences would not create substantial difficulties. However, in this case we would still only observe the outcome and not the market risk of property prices. Ideally, we would compare co-operatives with rental apartments on a yearly basis, for example by using dummy variables. This would require an average price per postal code per year; for a large number

[4]Google bases its geographical data on Cartesia GIS AB 2009, Lantmäteriet, Swedish Environmental Protection Agency, Vägverket 2009 and National Land Survey Sweden.

postal codes, this is not feasible. Restricting these annually is hence likely to be problematic. Instead, we created an adjusted price per square metre, using the average price change per area compiled by Mäklarstatistik, to be able to make comparisons across time (Mäklarstatistik, n.d.). By relating this to the size of each intermediated rental apartment, we created an approximate value for for all apartments.

Housing co-operatives also have a monthly fee to the co-operative organisation running the apartment building. These usually cover heating, water, maintenance, and loans. Since they vary in size between apartments and areas, largely depending on the age of the apartment, they ought to be a significant factor for prospective buyer. If we assume that buyers are indifferent between these and mortgage costs, we should be able to estimate their importance through their present value. To do so, we use the interest rates for the longest housing loans available. For the major Swedish banks, these are usually 8 to 10 years. The average of these give a rate of 3.25 per cent, which is used to calculate a perpetuity (Appendix).

$$\begin{aligned} Adjusted\,apartment\,value = {} & adjusted\,average\,price\,per\,square\,metre \\ & *surface\,area + PV(upkeep\,fee) \\ PV(upkeep\,fee) = {} & upkeep\,fee/r \end{aligned} \tag{8}$$

Average area income. We have obtained a data set with average income in ages 20 to 64 for all postal codes in Stockholm County compiled by Statistics Sweden. The data is on reported incomes 2009. Although the average area incomes are from a single year, we believe the usually slow pace of demographic transition ensure their continued relevance.

Total subsidy value. We calculate two different measures of subsidy value. First, we use the discounted total subsidy value. In order to estimate the net present value of the upkeep fee and the rent, we will first assume that the growth rate in the economy will equal the increase in the fees and rents. Secondly, we will ignore

the effect of the interest rate deduction available to homeowner.

$$Total\,subsidy\,value = Adjusted\,apartment\,value + PV(up\,keep\,fee) - PV(annual\,rent)$$
$$PV(rent) = annual\,rent/r \tag{9}$$

Annual subsidy value. When calculating the annual subsidy value, we use the opposite approach. We use the interest rate as the cost of capital for the apartment prices. This does not require us to make assumptions of the future growth rate, and presents a snapshot of the subsidies on a yearly basis.

$$Annual\,subsidy = Adjusted\,apartment\,value * r - annual\,rent \tag{10}$$

5.3.2 Main independent variables

Income. Any applicant having received an offer from the Housing Agency is required to hand in evidence of the reported income, in the form of written testimony from its employer or other official documents. Apartments cannot be intermediated to people with an income that is 0, and hence 1,551 observations were excluded. Up to the seventh decile, the incomes of applicants are higher than the general population in Stockholm County. We also adjusted the incomes with the general nominal wage increases. Using income from labour and excluding capital income, we are able to adjust all stated incomes to the level in 2014 using the most recent data from Statistics Sweden.

Queue time. The queue time is counted in years from the initial registration in the queue. Being the principal allocation device, it functions as a price mechanism in the intermediation system. Plotting income against queue time, we find a relatively even distribution with a correlation of 9.5 per cent. Examining the correlation between income and age, we find it to be next to non-existent. Consequently, the aforementioned correlation must be due to other factors.

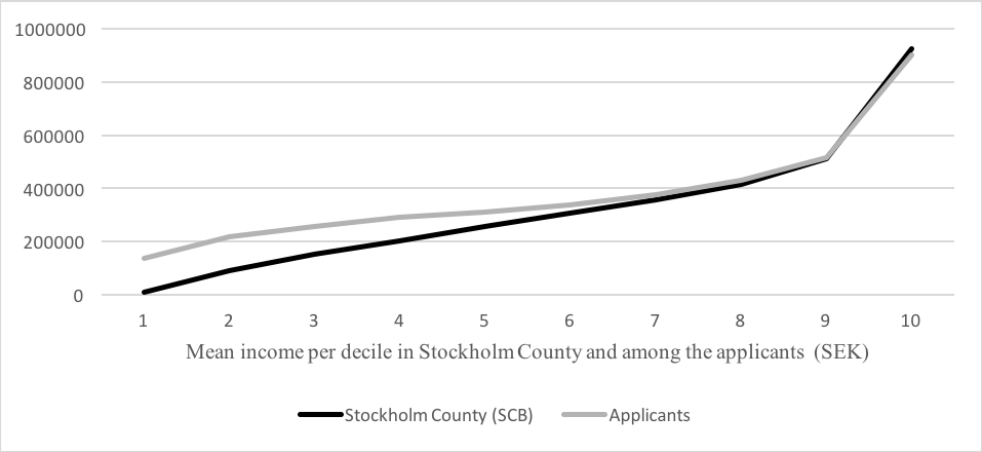

Figure 1: Income distribution among applicants

Rent. The rent is expressed in the monthly payment in terms of SEK.

5.3.3 Control variables

In order to find the most accurate weight of income, queue time, and rent in determining the dependent variable, we need to control for a number of things. Ideally, all the apartments would be of the same size, number of rooms and have the same standard in all other aspects. To this end, we add surface area, number of rooms and the floor of the apartment as control variables. In addition, we control for the age of the renter in the case there are different behaviour across age groups which can affect the influence of income and queue time.

5.4 Data transformation

Our data set from the Stockholm Housing Agency contains about 55,000 intermediated apartments in its original version (Appendix). The data set also contained about 1,500 observations with a registered income of zero. This is probably due to errors made by the administrator at the Stockholm Housing Agency. If an error is recognised the administrator will only supplement the missing information in mail or over telephone with the landlord. Hence, the proper income is not entered into the data base kept by the agency. We therefore remove these zero-income cases.

We also remove five extreme outliers with an income of 10 million SEK. We are not able to verify their size, but they are highly unlikely, might distort our analysis and the behaviour of such extreme cases is not the main focus of our analysis.

We choose to aggregate the prices to a postal code level in order to match it with the rental apartments. As we later will conclude, it gives a relatively small but sufficient area in order to pair the value of the co-operative apartments with the rental apartments. We then use a script linked to Google Maps to assign the observation to a postal code. However, the script used could only return postal codes for uniqe addresses in Stockholm county. Some generic names alluding to stations, main roads, or squares, such as 'Centralgatan' occur as street names in several municipalities, making our script unable to return postal codes for some of the results. In total we where unable to assign postal codes to about 6,000 observations.

Table 1: Summary statistics of intermediated apartments

Variable	Obs	Mean	Std. Dev.	Min	Max
Annual Income	40,151	354,564.5	222,965.8	24	1.00e+07
Year of queue time	40,151	6.763	4.213	.016	30.356
Monthly rent	40,151	6,042.668	2,270.914	1059	23,500
Number of rooms	40,151	2.311	.924	1	8
Surface_area	40,151	63.086	20.086	16	327

Data from 1 January 2006 to 31 December 2015

In Stockholm, major reforms where done to street names in the late 19th century when local and spontaneous names where replaced by centralised and sometimes ideological names. However, newer neighbourhoods in suburbs are often thematic, i.e. belong to some category such as vegetables or occupations (Johansson, 2007). Consequently, we have reason to believe that slightly more addresses are excluded in central locations than in the periphery.

To calculate a estimated market value or subsidy value we use data on sold co-operative apartments. Booli, a real estate search engine, uses a search algorithm to extract the final bid on co-operative apartments for sale when publicly available

from websites of real-estate agents. We cannot ensure that the data set is representative random sample of the sold apartments in the Stockholm County. However, the data set is consistent, since if we could increase our sample size we would come closer to the true population values. Very expensive apartments tend not to have public bids, which means that they are likely to be missing from the data. This would lead to a slight underestimation of the apartment value in areas where there are highly attractive co-operative apartments, e.g. Östermalm.

The Booli data set contains over 86,000 apartments with end prices from the years between 2012 to 2016 (Appendix). We use the same method as with the rental apartments to assign postal codes to all of those apartments. About 83,000 apartments could be assigned to a postal code. Examining the descriptive statistics of the sample including and excluding the non-assigned apartments, there is no notable difference in the minimal value, the maximum value, mean or variance between the data sets. One problem is that the price is not comparable between years, especially since there has been major increases in housing prices in the Stockholm region. To account for that we adjusted the prices with the average price increase on the municipal level. In order to make the rental apartments comparable, we also adjust the rents from years before 2015 with the general rent increase.

Comparing the statistics before and after the postal codes have been assigned we can note that the change in both mean and variance is small. This indicates that our failure to assign postal codes to some rental apartments is distributed fairly randomly. Hence, there is some evidence that that while the potential of a systematic street name problem should be kept in mind, it is likely to have a quite small impact.

To assign a price to the rental apartments we calculate a price per square metre for each of the co-operative apartment, based on the adjusted price, and then calculate the average price per square metre per postal code. The number of underlying cooperative apartments for each postal code differ widely. The mean is 62 observation per assigned postal code with a standard deviation of 52.

Table 2: Summary statistics of matching co-operative apartments

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	84,300	314,8503	1,861,885		
Adjusted Price	82,338	1,175,362	609,758.5		
Size	82,343	71.044	36.172		
Monthly upkeep fee	74,611	3411.357	1,374.952		
Data from 1 January 2012 to 31 December 2015					

Table 3: Summary statistics price per postal code

Matches	Obs	Mean	Std. Dev.	Min	Max
Co-operatives with postal codes	82,630	49.14537964	45.34427258	0	339
Postal code with rental apartments	31,821	61.934	51.553	0	341

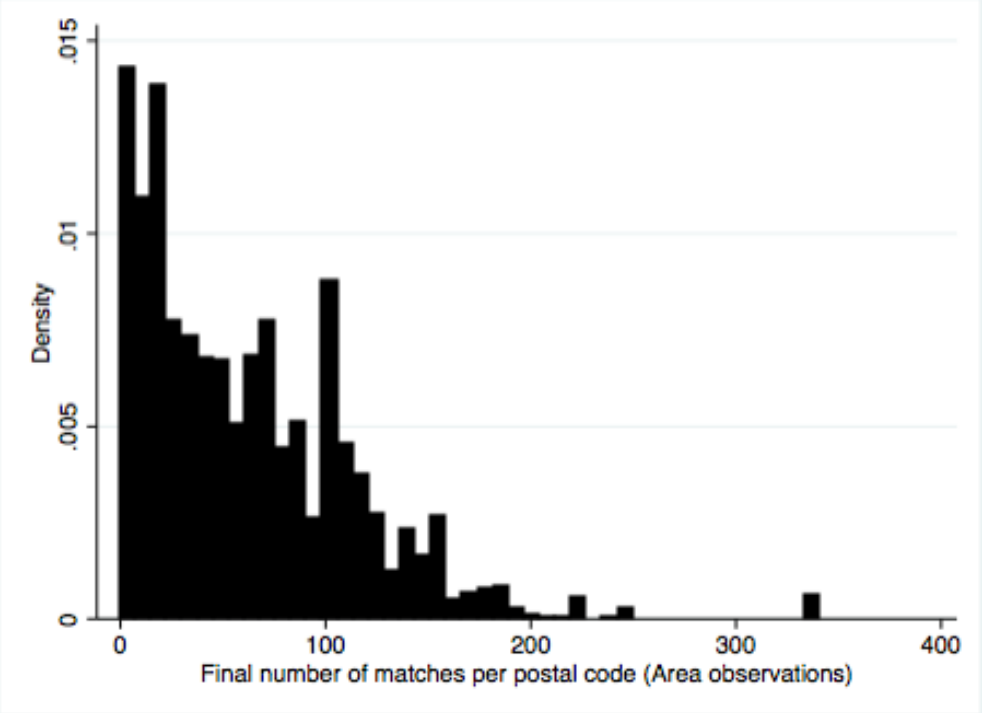

Figure 2: Distribution of matches per postal code used to estimate value

There are two major concerns that could be raised about the uneven distribution of matching co-operative apartments. First, the amount of sold cooperative apartments could correlate with some features that effect the value of a rental apartment. The correlation between matches, which we henceforth will designate area observations, and important characteristics of the rental apartments is notable (Appendix). In the case of rent, price per square metre, queue time and income of the particular area, the correlation is as high as between 15 and 32 per cent. The high correlations between characteristics will create a omitted variables bias if not controlled for. Therefore we expand our control variables to include the number of area observations and exclude apartments that have less than 5 observations per area. Comparing the descriptive statistics before and after the removal of these apartments resulted in negligible changes (Appendix).

6 Results

In this section we are going to test our hypotheses about the egalitarian nature of the system, the allocation of apartment values and if there is evidence of self-segregation. We commence our quantitative analysis by regressing our dependent variables adjusted apartment value, average area income and subsidy value on income, queue time, and a number of control variables.

For ease of interpretation we choose to logarithmise all our dependent variables and income and rent, but queue time remains expressed in year and our control variables are also in their original forms. While apartment value and subsidy value are based on the same data, they offer slightly different implications. Apartment value can be viewed as either the estimated apartment value, or the subsidy value, which represents the 'profit' made due to the rental regulation. The total and annual subsidy values require slightly different assumptions. Area income provides a further measure in relation to self-segregation. The different necessary assumptions and data sources enable us to provide a more sophisticated analysis, while strengthening the interpretation if similar trends can be discovered across the results.

$$\begin{aligned} Log\,apartment\,value = \beta_0 + \beta_1(queue\,time) + \beta_2(log\,rent) + \beta_3(log\,income) \\ +\beta_5(rooms) + \beta_6(floor) + \beta_7(surface\,area) + \beta_7(area\,observations) \end{aligned} \tag{11}$$

$$\begin{aligned} Log\,area\,income = \beta_0 + \beta_1(queue\,time) + \beta_2(log\,rent) + \beta_3(log\,income) \\ +\beta_5(rooms) + \beta_6(floor) + \beta_7(surface\,area) + \beta_7(area\,observations) \end{aligned} \tag{12}$$

$$\begin{aligned} Log\,subsidy\,value = \beta_0 + \beta_1(queue\,time) + \beta_2(log\,rent) + \beta_3(log\,income) \\ +\beta_5(rooms) + \beta_6(floor) + \beta_7(surface\,area) + \beta_7(area\,observations) \end{aligned} \tag{13}$$

$$\begin{aligned} Log\,annual\,subsidy = \beta_0 + \beta_1(queue\,time) + \beta_2(log\,rent) + \beta_3(log\,income) \\ +\beta_5(rooms) + \beta_6(floor) + \beta_7(surface\,area) + \beta_7(area\,observations) \end{aligned} \tag{14}$$

We run the regression for two separate categories — public housing companies and private landlords. The relative size of the coefficients are significantly different, but the explanatory power is about the same. With a large data set, we will only present robust standard errors, making assumptions of homoscedasticity redundant.

To begin with, we regress our first dependent variable, estimated adjusted apartment value, on our independent variables. The regression of the estimated adjusted apartment value yields a very high explanatory power of about 78 per cent for public and 82 per cent for private landlords. Using this measure, we are able to reject all our hypotheses since all our main coefficients are significantly different from zero. A one year increase in in queue time will result in a 2.4 per cent increase of apartment value in the case of public housing companies and 3.1 per cent in the case of private landlords. In the case of rent, a one per cent rent increase will increase the value of the apartment by 0.4 per cent in public housing and 0.69 per cent in private. The magnitude of income is substantially smaller, where a one per cent increases apartment value by about 0.02 per cent in both private and public housing. The average area income explains less of the variation, especially in the case of private companies. The income coefficient is significant here as well, supporting the rejection our third hypothesis.

To try to understand the individual importance of each main dependent variable, we run the regression on adjusted value and add the variables incrementally. We can see that income initially explains a large part of the variation. This persists when adding queue time. However, when the rent is added the magnitude of the income coefficient decreases. Consequently, income primarily acts through the rent of the apartment, while queue time and rent appear to be the most independently important factors. The high explanatory power indicates that these three are important variables to understand the allocation of apartment value.

VARIABLES	Public Log adj. value	Private Log adj. value	Public Log area income	Private Log area income
Log adj. income	0.0194***	0.0226***	0.0459***	0.0335***
	(0.00285)	(0.00425)	(0.00371)	(0.00628)
Years queued	0.0240***	0.0310***	0.0206***	0.0182***
	(0.000320)	(0.000422)	(0.000424)	(0.000587)
Log adj. rent	0.392***	0.687***	0.483***	0.471***
	(0.00788)	(0.00870)	(0.0121)	(0.0140)
Rooms	-0.0172***	-0.0709***	-0.0190***	-0.0310***
	(0.00383)	(0.00457)	(0.00535)	(0.00613)
Floor	-0.00671***	0.000781	-0.00812***	-0.00121
	(0.000655)	(0.000858)	(0.000955)	(0.00130)
Surface area	0.0100***	0.00904***	-0.00706***	-0.00554***
	(0.000241)	(0.000247)	(0.000368)	(0.000355)
Area observations	0.000806***	0.00128***	0.00110***	0.000435***
	(2.48e-05)	(4.05e-05)	(3.19e-05)	(5.26e-05)
Constant	10.59***	8.002***	7.807***	8.172***
	(0.0645)	(0.0733)	(0.0992)	(0.121)
Observations	18,557	11,702	18,557	11,702
R-squared	0.779	0.818	0.359	0.239

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression on apartment value and average area income

VARIABLES	Log. adj value	Log adj. value	Log adj. value
Log adj. income	0.0870***	0.0693***	0.0142***
	(0.00366)	(0.00326)	(0.00221)
Years queued		0.0235***	0.0268***
		(0.000283)	(0.000250)
Log adj. rent			0.515***
			(0.00570)
Rooms	-0.0378***	-0.0378***	-0.0347***
	(0.00445)	(0.00422)	(0.00297)
Floor	0.00275***	0.000579	-0.00452***
	(0.000612)	(0.000562)	(0.000475)
Surface area	0.0159***	0.0159***	0.00920***
	(0.000241)	(0.000232)	(0.000173)
Area observations	0.00168***	0.00146***	0.000938***
	(2.49e-05)	(2.19e-05)	(1.99e-05)
Private landlord	0.00423	0.0241***	-0.0171***
	(0.00274)	(0.00249)	(0.00218)
Constant	12.98***	13.05***	9.617***
	(0.0445)	(0.0395)	(0.0465)
Observations	36,416	36,416	36,416
R-squared	0.638	0.700	0.767

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regression on apartment value with incremental addition of main variables

In order to further examine of the effect of queue time and income on the apartment value received by the applicant, we divide the two variables into deciles and run regressions with these instead. This allows us to better capture any non-linear relation between the independent variable and dependent variable. We use decile 5 as our base since it is close to the centre and makes comparisons more understandable. When splitting the queue time variable, we notice that the effect of additional queue time is fairly linear, but with greater changes in the lower and higher deciles. In quantitative terms, an applicant in the first decile gains on average an apartment with a 54 per cent lower adjusted apartment value and 14 per cent lower subsidy value than a person in the fifth decile. The seventh decile gains on average a 19 per cent more valuable apartment with a 6 per cent higher subsidy than an applicant in the fifth decile and a person in the tenth decile on

average gets a 79 per cent more valuable apartment with a 28 per cent higher subsidy.

When performing the same procedure for the income deciles, we do not get the same effect. For incomes below the seventh decile there is either no or low significance, and in the case of total apartment value only the top decile is highly significant. From the seventh decile, however, we observe a small but significant non-linear increase in the effect of income. A person in the tenth income decile gains on average a 2.7 per cent more valuable apartment with a 6.3 per cent higher subsidy in an area with a 6.8 per cent average income than a person in the fifth decile.

We also conduct a regression on the total subsidy value. In this case, the explanatory power of the regression is lower yet still substantial at 33 per cent for both for public and 37 per cent for private housing companies. Once more, all our coeffients are significant, which supports a rejection of our hypothesis. The magnitude of the queue time coefficients is substantially larger than for adjusted apartment value, at 7 and 10 per cent. The income coeffients are also larger than in the previous regressions, especially for private housing. High rents are associated with lower gains, more so in the case of public housing.

The correlation of subsidy value (Appendix) and adjusted price is 78.1 per cent, which means that apartments with high estimated market values also account for the largest subsidies. The correlation between the income and subsidy value is low, 15.8 per cent, and does not increase as we exclude people with low incomes. When dividing the income and queue time into deciles we observe the same pattern with a linear relationship for the lower deciles and a spike in the higher deciles as for adjusted value, but with greater magnitude of the coefficients.

In order to examine the distribution effect across income groups, we calculate the total subsidy across income deciles. Our initial measure, where we use the raw data, shows that the total subsidies seem to have a weakly positive linear relationship with income groups, with an increase at the top. We then adjust it by performing a regression with all our independent variables except income and plot the residuals against income queue time. This shows little relation with income, except for the

VARIABLES	Log subsidy value	Log adj. price
Log adj. income	0.0268***	0.0720***
	(0.00255)	(0.0103)
Log adj. rent	0.523***	-0.525***
	(0.00627)	(0.0263)
Room	-0.0470***	-0.133***
	(0.00314)	(0.0127)
Floor	-0.00295***	-0.000688
	(0.000539)	(0.00236)
Surface area	0.00974***	0.0290***
	(0.000191)	(0.000796)
Area observations	0.000889***	0.00240***
	(2.28e-05)	(8.76e-05)
Private landlord	-0.0130***	-0.00878
	(0.00230)	(0.0104)
Years queued 1	-0.136***	-0.544***
	(0.00536)	(0.0281)
Years queued 2	-0.0797***	-0.341***
	(0.00525)	(0.0256)
Years queued 3	-0.0367***	-0.176***
	(0.00497)	(0.0232)
Years queued 4	-0.0177***	-0.0691***
	(0.00489)	(0.0220)
Years queued 6	0.0304***	0.0875***
	(0.00467)	(0.0202)
Years queued 7	0.0576***	0.185***
	(0.00466)	(0.0192)
Years queued 8	0.102***	0.314***
	(0.00453)	(0.0184)
Years queued 9	0.161***	0.490***
	(0.00438)	(0.0176)
Years queued 10	0.283***	0.789***
	(0.00476)	(0.0173)
Constant	9.535***	15.71***
	(0.0514)	(0.215)
Observations	30,473	27,446
R-squared	0.782	0.330

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Regression on apartment and subsidy value with queue time divided into deciles

VARIABLES	Log subsidy value	Log area income	Log adj. price
Years queued	0.0272***	0.0195***	0.0811***
	(0.000257)	(0.000366)	(0.000956)
Log adj. rent	0.524***	0.471***	-0.532***
	(0.00623)	(0.0102)	(0.0265)
Rooms	-0.0413***	-0.0291***	-0.109***
	(0.00315)	(0.00469)	(0.0128)
Floor	-0.00327***	-0.00621***	-0.00112
	(0.000539)	(0.000771)	(0.00237)
Surface area	0.00932***	-0.00603***	0.0270***
	(0.000192)	(0.000326)	(0.000795)
Area observation	0.000912***	0.000859***	0.00250***
	(2.26e-05)	(2.87e-05)	(8.74e-05)
Private landlord	-0.0131***	0.117***	-0.0127
	(0.00229)	(0.00310)	(0.0105)
Income 1	-0.00280	-0.00716	-0.0489**
	(0.00506)	(0.00582)	(0.0209)
Income 2	-0.00532	-0.00955	-0.0402*
	(0.00501)	(0.00600)	(0.0209)
Income 3	-0.00789	-0.0133**	-0.0478**
	(0.00489)	(0.00575)	(0.0206)
Income 4	0.000565	-0.0115**	-0.0468**
	(0.00479)	(0.00571)	(0.0209)
Income 6	0.00491	0.00666	-0.0226
	(0.00455)	(0.00559)	(0.0190)
Income 7	0.00709	0.00868	-0.0209
	(0.00491)	(0.00594)	(0.0203)
Income 8	0.0150***	0.0170***	0.00793
	(0.00464)	(0.00580)	(0.0194)
Income 9	0.0174***	0.0394***	0.00999
	(0.00483)	(0.00648)	(0.0201)
Income 10	0.0266***	0.0676***	0.0626***
	(0.00482)	(0.00692)	(0.0198)
Constant	9.726***	8.471***	16.30***
	(0.0494)	(0.0795)	(0.207)
Observations	30,473	30,473	27,446
R-squared	0.785	0.360	0.323

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Regression on apartment, subsidy value and area income with income divided into deciles

VARIABLES	Public Log Tot. Subsidy	Private Log Tot. Subsidy	Public Log Ann. Subsidy	Private Log Ann. Subsidy
Log adj. income	0.0445***	0.0849***	0.0445***	0.0849***
	(0.0117)	(0.0193)	(0.0117)	(0.0193)
Years queued	0.0697***	0.0968***	0.0697***	0.0968***
	(0.00117)	(0.00163)	(0.00117)	(0.00163)
Log adj. rent	-0.960***	-0.0582	-0.960***	-0.0582
	(0.0356)	(0.0383)	(0.0356)	(0.0383)
Rooms	-0.0485***	-0.190***	-0.0485***	-0.190***
	(0.0165)	(0.0181)	(0.0165)	(0.0181)
Floor	-0.0151***	0.0122***	-0.0151***	0.0122***
	(0.00294)	(0.00386)	(0.00294)	(0.00386)
Surface area	0.0323***	0.0240***	0.0323***	0.0240***
	(0.00107)	(0.00100)	(0.00107)	(0.00100)
Area observations	0.00230***	0.00359***	0.00230***	0.00359***
	(0.000102)	(0.000156)	(0.000102)	(0.000156)
Constant	19.15***	11.10***	15.72***	7.674***
	(0.286)	(0.329)	(0.286)	(0.329)
Observations	17,108	10,146	17,108	10,146
R-squared	0.325	0.374	0.325	0.374

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Regression on total subsidy value and annual subsidy value

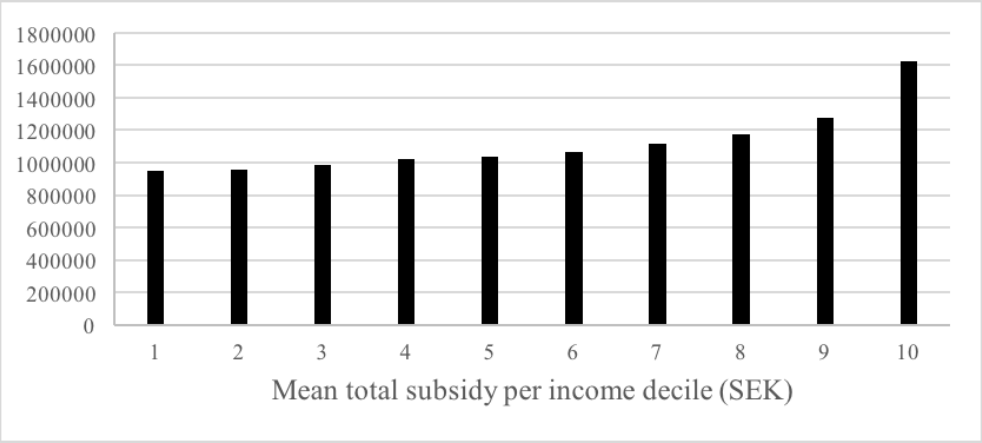

Figure 3: Mean total subsidy value for each income decile

highest decile which derives a gain independent of queue time, rent and our control variables (Appendix).

We also performed regressions on total value and subsidy value separately for different numbers of rooms. These indicate a decreasing importance of queue time and income for the total value, and an increasing importance of rent. For subsidy value, the same trends are observed, apart from a decreasing importance of rent (Appendix). There are no major differences such as sign changes, and since we limit the applicants and hence the variation of the independent variables when considering smaller subsets of apartments, the results should be interpreted with care. However, the general trend appears to be that queue time becomes less important for larger apartments, along with income. The extent to which this reflects structural differences among the applicants is uncertain.

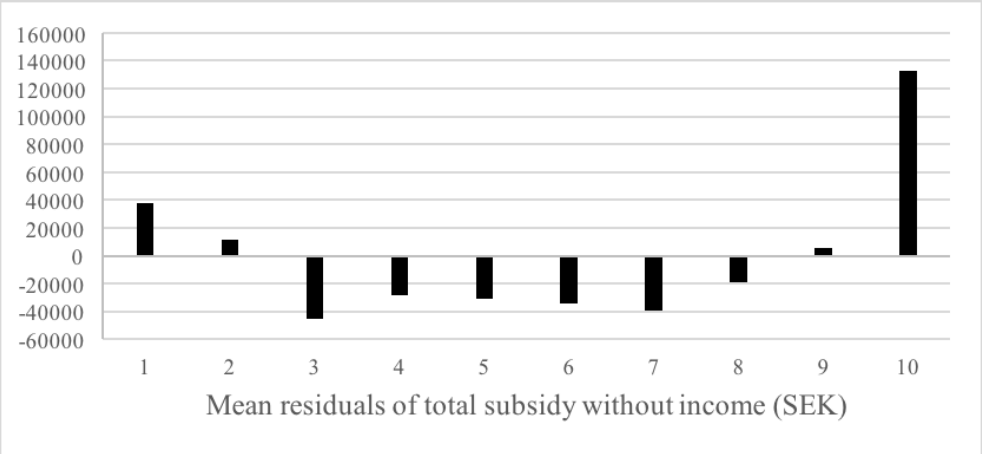

Figure 4: Mean total subsidy value for each income decile adjusted for queue time, rent and other control variables

6.1 Considerations and sensitivity analysis

In this section we examine correlation between variables, the effect of adjusting the price to the price development and perform a sensitivity analysis concerning our assumed discount rate. We calculate the correlation between our independent variables in order to examine if there is collinearity present. Beginning with our main independent variables, queue time and income are weakly correlated, while rent and income show a correlation of 0.40. In the case of our control variables, surface area and the number of rooms have a very high correlation, 0.91, which is expected and unproblematic since these only serve as control variables. These also have a high degree of correlation with rent. However, considering our key focus, there is no correlation between main variables to the extent that they are completely explained by each other. This is also illustrated in the scatter plots in our Appendix.

Compared with the prices unadjusted for the price development over time and in different areas (Appendix), the regression with adjusted prices displays a much higher degree of explained variation. Simultaneously, the size of the coefficients is reduced. Since the adjusted prices have a much greater explanatory power, it is a preferable method. Using a fixed effect regression to see the fit of a pure square metre relationship on our co-operative data, we are able to explain the variation to

Table 9: Cross-correlation of independent variables

Variables	Income	Queue time	Rent	Room	Floor
Income	1.000				
Year Queued	0.110	1.000			
Rent	0.404	0.135	1.000		
Rooms	0.199	0.027	0.626	1.000	
Floor	0.081	0.069	0.175	0.102	1.000
Surface Area	0.202	0.012	0.676	0.911	0.106

VARIABLES	Log Adjusted Price
Log Price Per Sq.	0.824***
	(0.00331)
Constant	5.821***
	(0.0314)
R-squared	
Within	0.8195
Between	0.9711
Overall	0.8859
Observations	82,338
Number of postal codes	1,649

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Regression on apartment value for cooperatives with the price per square meter, fixed effect: Postal codes

a very high degree. This, along with data illustrated in the scatter plot, indicates that our estimation of market value using square metre price per postal code is likely to be fairly accurate. We exclude apartments with a price of 20,000,000 and sqm price of 250,000 in the diagram for illustrative purposes, 1962 observations in total.

In order to make sure our results are as reliable as possible, we perform a sensitivity analysis on our estimated variables by changing our estimate of the interest rate. By increasing and decreasing the interest rate when calculating the subsidy value and the apartment value, we observe substantial change in the coefficients of both regressions. Since our assumed discount rate is 3.25 per cent, a increase or decrease of 100 basis points represents a large relative change. In addition, the long-term discount rate is unlikely to be highly volatile. We notice that lowering the interest rate has a positive effect on the income coefficient and the rent coefficient across

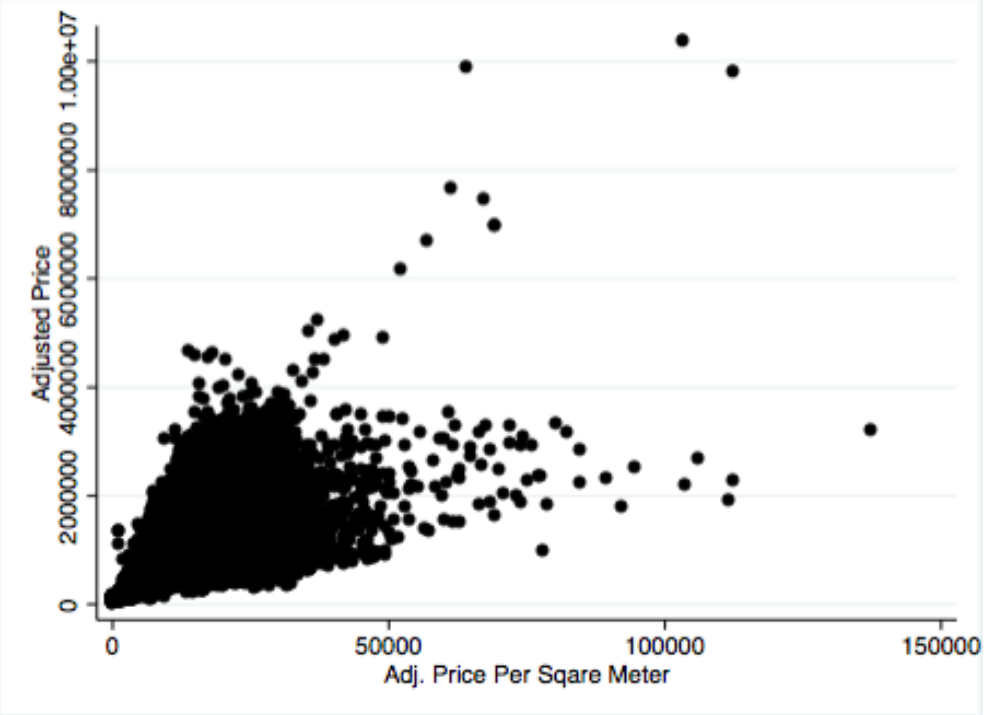

Figure 5: Scatter of Adjusted price and Adjusted Square meter price

the board, and vice versa. In opposite, it has negative effect on the queue time coefficient. However, all coefficients remain highly significant and there are no sign changes, indicating that the results are reliable unless the discount rate used is radically different from those offered on long-term mortgages.

Table 11: Sensitivity analysis of interest rate - public housing

Log adj. income	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	0.0612***	0.0445***	0.0498***
Annual subsidy	0.0612***	0.0445***	0.0498***
Adjusted price	0.0227***	0.0194***	0.0144***
Year queued	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	0.0608***	0.0697***	0.0792***
Annual subsidy	0.0608***	0.0697***	0.0792***
Adjusted price	0.0258***	0.0240***	0.0212***
Log rent	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	-0.541***	-0.960***	-1.866***
Annual subsidy	-0.541***	-0.960***	-1.866***
Adjusted price	0.415***	0.392***	0.356***
*** p<0.01, ** p<0.05, * p<0.1			

Table 12: Sensitivity analysis of interest rate - private housing

Log income	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	0.0899***	0.0849***	0.0655**
Annual subsidy	0.0620***	0.0680***	0.0235
Adjusted price	0.0244***	0.0229***	0.0199***
Year queued	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	0.0814***	0.0968***	0.106***
Annual subsidy	0.0819***	0.0972***	0.0974***
Adjusted price	0.0330***	0.0272***	0.0280***
Log rent	Low (2.25%)	Normal (3.25%)	High (4.25%)
Total Subsidy	0.323***	-0.0582	-1.022***
Annual subsidy	0.172***	-0.287***	-0.982***
Adjusted price	0.712***	0.517***	0.648***
*** p<0.01, ** p<0.05, * p<0.1			

7 Discussion

7.1 Findings

In this discussion, we will analyse the results primarily with regard to the importance of income, queue time and rent. The system's effect on segregation and distribution of value will then be considered.

Our ability to reject the hypothesis about queue time having no impact means that the current system is more egalitarian than a system with pure market rents, at least within the current system of housing. In an idealised perfect market, the only variable explaining apartment value for rental apartments would be the rent, given that the contractual features and regulations are identical across apartments. In this case, queue time is of substantial importance which represents an improvement in egalitarian terms in compared to a market allocation. Queue time is accessible to everyone on relatively equal terms, despite the presence of a small annual fee, and since the correlation with income is weak and the income distribution of the applicants largely reflects the overall income distribution of Stockholm it appears rather egalitarian. Hence, there is no indication that low-income groups are forced to exercise their queue time option earlier which would preclude them from collecting long queue times. However, individuals with very low incomes are underrepresented among applicants, which indicates that they either cannot get an apartment through the Stockholm housing agency or that they are absent from the system. Naturally, the queue time correlates with age, which is the main difference from a completely egalitarian solution in terms of opportunity, such as a lottery.

Along with queue time, rent is the main predictor of apartment market value, enabling to reject our second hypothesis. When performing regressions, we noticed that they were able to explain most of the variation in apartment value and to a lesser extent the distribution of subsidy value, being more important than income. This means that the housing queue retains a important market feature. The rent correlates strongly with the size, which is no surprise since the utility value system considers both size and standard, and to a much lesser extent location, to be legitimate determinants of rent. It implies, however, that more extensive regulation would be necessary for a purely egalitarian system without market mechanisms.

As we have established that the importance of rent is significant, we can consider the effects of the system on different income groups. Looking at its distribution across income deciles, we find that the gain from the rental regulation increases with income, between 30,000 and 50,000 per year or 1 to 1.5 million as a perpetuity from the lowest to the highest decile. Since our estimate assumes equal standard of rental apartments and housing co-operatives, the true value is likely to be slightly lower. The subsidy constitutes a proportional subsidy to rent. Of course, the effect of this is that the largest cost decreases are received by the households with the highest incomes. We can be fairly sure that although this also correlates with the size of apartments, the main reason that high-income groups derive the largest gains are that they can afford the rent, rather than a unique preference for large apartments. However, when adjusting for rent and queue time, we notice that the highest decile still seems to be getting an abnormal subsidy equivalent to perpetuity of about 180,000. This is in line with previous studies that have shown that high-income groups tend to make better decisions regarding their use of free public founded services, which is partly analogous. Since low-income groups are underrepresented among those receiving apartments, the gains from the municipal queue are even more skewed to the right of the distribution. Naturally, high income earners as whole might lose as indicated by Sah, even if those who manage to rent apartments gain.

The precondition for observing income-based self-segregation is the inability to costlessly realise the market value of the queue time. Should self-segregation exist,

we would expect the mechanism to be present in perfect markets as well. However, in that case we can only observe how much people spend on housing, not what they are willing to spend, and money not spent on housing can be used to buy something else. In contrast, with a housing queue we know the queue time, the surplus queue time disappears and the value of the regulated contract can only be realised through costly and complicated means, such as legally swapping contracts or selling them on the black market. This explains why people could use their queue time in an inefficient way in relation to market value.

We do find that the income appears to have a small but significant effect on both average income and apartment value, enabling us to formally reject the hypothesis. However, when examining the distribution between deciles, we find that the largest effect of income on adjusted value and total subsidy value is due to the the top decile, which is highly significant, while the behaviour of lower deciles is inconclusive. This group appears to be more successful in acquiring both the highest subsidies and valuable apartments. In the case of area income, there is more obvious evidence of self-segregation. Both the lowest and highest deciles show significant income coefficients, indicating that they live in areas with lower or higher incomes than the rent and queue time would indicate on average. A further caution should be raised as our amount of observations is fairly large which yields significant results even with small coefficients, but if the discount rate is low enough our regressions yield insignificant results for income as an explanatory variable for adjusted apartment value. In conclusion, while there is some evidence supporting the existence of self-segregation, the small magnitude of the coefficient paints an ambiguous picture.

As discussed in our background, self-segregation studies typically focus on race and ethnicity. It would not be unreasonable to assume this accounts for a portion of our income effect as well. Immigrants and their children generally earn less in Sweden, and there are studies indicating self-segregation (Skans & Åslund, 2009). Such segregation would also be likely to expressed through our income variable. However, our lack of data on ethnicity and origin means that we cannot adequately explain the possible size of this effect. One third of the inhabitants in Stockholm county are first- or second-generation immigrants. As they are overrepresented in

low-income groups and underrepresented in high-income groups, a large amount of ethnical self-segregation would be likely to be expressed through the income channel. The small size of income and the partial insignificance implies that this cannot be a major factor, at least within the queue system. Instead, the often observed self-segregation is likely to be due to other unobserved constraints.

Another potential cause for income segregation could be that individuals with low income have less opportunity to wait for the optimal apartment. For example, in the case of a divorce or other crisis with housing implications people with high incomes could finance a temporary solution more easily and wait for an attractive apartment, while low income earners would be forced to use their queue time for a suboptimal apartment. High-income earners might also see the queue membership as an option to higher degree, since they are more likely to be able to afford their desired housing by buying housing. Since we have a situation where we know a person can choose to move to different areas, this provides new insights to self-segregation. We find a largely efficient system in relation to queue time and rent, where self-segregation is a negligible feature.

7.2 Implications and future research

Our study does indicate that there is a minor degree of self-segregation. Of course, this is on an aggregate level; for particular groups such as ethnic minorities it might be of greater importance. However, we can be fairly sure that self-segregation is of secondary importance to explain the severe segregation we witness in Stockholm, and that rather the distribution of economic means is the primary factor. One alternative would be that queue time is substantially unevenly distributed, which does not seem to be true within the queue. However, the absence of some low-income individuals may distort conclusions concerning the importance of income-related preferences. Another possibility would be that ethnic minorities choose to reside in equally attractive but ethnically segregated areas, like in Södertälje which has a large Assyrian population. However, we have reason to believe that the range of ethnically segregated areas in Stockholm in terms of average income is limited. Consequently, if the income of individuals belonging minorities is more widely

distributed, high-income members would have to select areas not reflecting their own income to be able segregate. This is an aspect that could be studied further.

The rental regulation is often defended in terms of its egalitarian impact. From our study, we can conclude that there is indeed a substantial theoretical egalitarianism involved, expressed in the reduced importance of rent when predicting the value of an apartment received and the importance of queue time. However, it also results in reduced rents that primarily benefit high-income groups, resulting a distribution of gains that is skewed towards high-income groups. Therefore the effect is twofold, and it is not obvious that the system benefits marginalised groups in accordance with its egalitarian intentions.

A concern that should be addressed when interpreting the results in a wider context is the seemingly fair assumptions about how apartments would be distributed in the case of the absence of a rent regulation. There is some critique of the underlying free-market assumptions: some of the landlords can get monopolistic power in areas with few landlords, asymmetric information can distort price setting and large transaction cost can distort bargaining powers (Lind, 2008). To some extent, these problems are likely to exist in co-operative apartments as well. However, any systematic differences would pose a problem, and comparative empirical studies on unregulated rental markets would be needed to address this. We also have to keep in mind that our data only covers intermediated apartments, and while they are likely to give some indication of the state of the stock, we cannot be sure it is an unbiased sample. However, since our main focus is the current change, this is not a major problem.

The large size of the estimated subsidies, and its unfavourable distribution from an egalitarian perspective, gives strong implications for policy. With register data and more extensive information on apartment prices, these results could be put on a still more solid foundation either using queue data or, if possible, information on the income of individuals in the housing stock.

8 Concluding remarks

In this paper we have analysed the outcome of the Stockholm Housing Agency intermediation of about 36,000 apartments via their queue. By estimating the market price using more than 80,000 co-operative apartments on a postal code basis and the average area income, we find the impact of income, queue time and rent on their allocation.

- Queue time is an important factor in the allocation of apartment and subsidy value. This indicates an egalitarian improvement compared to free market, especially if one manages to establish equal access to the queue.
- We find the rental regulation it gives a subsidy ranging from 55 to 60 per cent of the annual rent cost, in absolute terms benefiting individuals with high incomes since it is proportional to rent.
- In the price regulated rental market in Stockholm, rent remains a substantial and significant factor. Normal market processes are still of substantial importance.
- The income of the applicant has an ambiguous effect on the allocation when controlling for other factors. In the case of apartment and subsidy values, we primarily find evidence that the top earners receive slightly more valuable and subsidised apartments. Low-income groups do not deviate significantly from the rest of the population in relation to apartment and subsidy value. However, we notice some evidence of self-segregation in relation to average area income both in low-income and high-income groups.
- Given these results, we find that the system introduces egalitarian features, but largely follows a distribution profile similar to market alternatives, where top earners get most of the absolute value. If policymakers aim to avoid giving large rent cut individuals with high incomes, other alternatives should be considered.

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A Appendix

Table 13: Summary statistics: Intermediated apartments by Stockholm Hosuing Agency

Variable	Obs	Mean	Std. Dev.	Min	Max
Annual Income	54094	371970.1	2102106	0	4.73e+08
Year of queue time	54094	6.546	4.112	.016	30.54
Monthly rent	54094	6373.237	2582.46	1059	26697
Number of rooms	54094	2.335	.931	1	8
Surface Area	54094	63.559	20.086	16	327
Data from 1 January 2006 to 31 December 2015					

Table 14: Summary statistics: Booli data

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	86677	3143732	1873273	95000	5.00e+07
Size	83903	71.267	36.404	0	990
Monthly upkeep fee	75671	3404.543	1381.25	0	28000
Data from 1 January 2012 to 31 December 2015					

Income group	Stocholm County	Applicants
Decile 1	11,381	137,052
Decile 2	90,092	218,811
Decile 3	153,574	256,739
Decile 4	204,596	290,851
Decile 5	255,604	313,042
Decile 6	306,022	339,025
Decile 7	355,715	378,631
Decile 8	416,620	431,773
Decile 9	513,026	515,842
Decile 10	924,967	902,220

Table 15: Apartment variables correlation with the number of area observations

Variables	Area Observations
Adjusted Income	0.133
Year of queue	0.186
Rent	0.0159
Room	-0.015
Floor	0.037
Surface Area	-0.041

Bank	Maturity (Years)	Interest Rate
Nordea	8	3.45
SEB	10	3.2
Handelsbanken	10	3.11
Swedbank	10	3.23
Average		3.25

From 15 Maj 2016

Table 16: Long-term mortgage interest rates

Table 17: Summary statistics after dropping areas with fewer than 5 matches.

Variable	Obs	Mean	Std. Dev.	Min	Max
Log adj. Income	38803	12.759	.519	3.307	16.24
Year Queued	38803	6.821	4.229	.016	30.356
Monthly Rent	38803	6058.814	2287.651	1059	23500
Rooms	38803	2.307	.923	1	8
Surface Area	38803	62.947	20.041	16	327

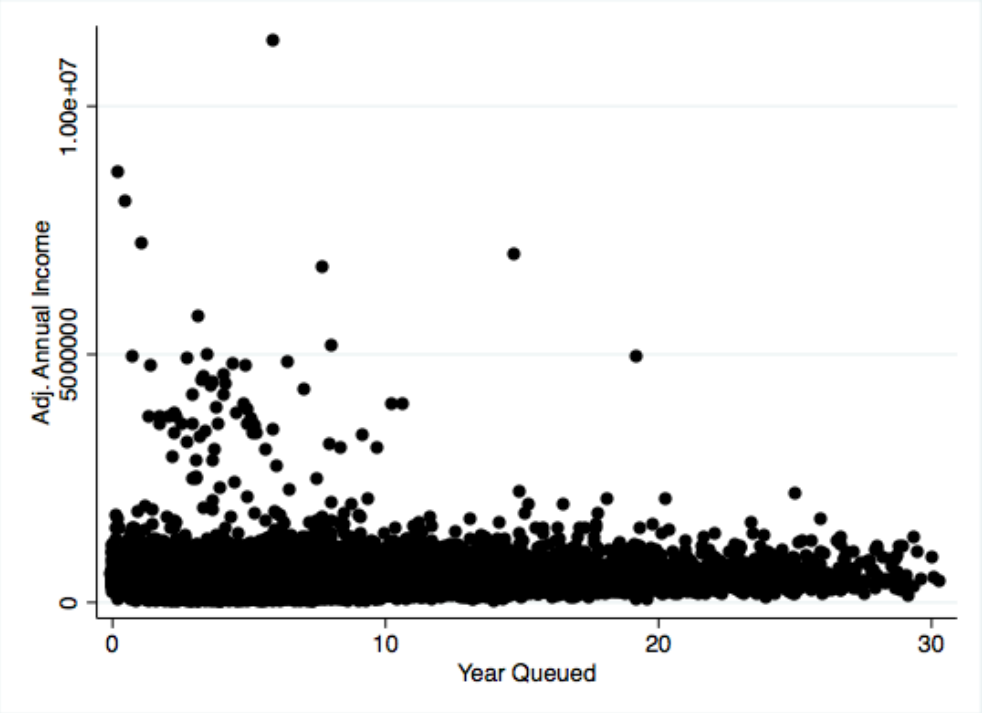

Figure 6: Scatter of annual income and queue time

Table 18: Summary statistics: total subsidy value per deciles

Decil	Obs	Mean	Std. Dev.	Min	Max
1	3424	928716	814575.6	-2162800	6931817
2	3890	923922.2	824589.1	-1738010	6017471
3	3139	947473.7	844295.8	-1812693	5708036
4	4573	966091.9	886736.3	-1566602	8927020
5	2164	986049.5	917477.2	-1371175	6415313
6	3766	998285	945598.4	-1775779	7215049
7	4374	1047855	1000818	-2262058	1.31e+07
8	3142	1104623	1114740	-2049867	1.95e+07
9	3863	1182858	1150857	-2263041	1.25e+07
10	4081	1530862	1420135	-2627341	1.56e+07

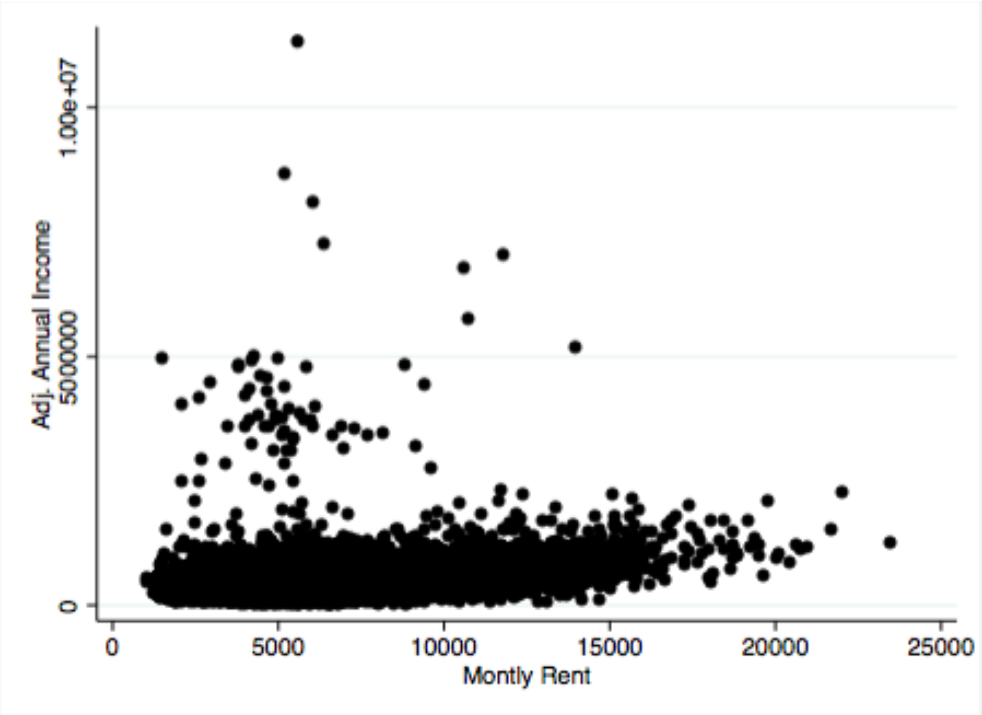

Figure 7: Scatter of annual income and monthly rent

Table 19: Mean total subsidy value for each income decile adjusted for queue time,rent and other control variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Decile 1	2754	37519.2	607240.9	-3332999	3023048
Decile 2	2815	11415.54	630457.2	-2507273	2938747
Decile 3	2850	-45614.81	624112.7	-2656656	2483275
Decile 4	2930	-28583.38	635539.2	-2926872	3619190
Decile 5	3022	-31081.69	657496.9	-2936415	4167151
Decile 6	3672	-34742.21	658605.3	-2379302	3471356
Decile 7	2609	-39702.07	688074.7	-3915684	6647005
Decile 8	3519	-19149.77	737721.3	-3606999	1.22e+07
Decile 9	2868	5372.049	757263.7	-3038062	6130375
Decile 10 3434	132601.9	938521.4	-5305773	8543898	

Table 20: Summary statistics: annual subsidy value per deciles

Decil	Obs	Mean	Std. Dev.	Min	Max
Decile 1	2754	30767.28	25336.37	-40841.29	179263.7
Decile 2	2815	31083.37	27021.92	-36062.09	225284.1
Decile 3	2850	31938.13	26516.06	-35736.04	167715.9
Decile 4	2930	33157.33	27074.88	-40882.27	226099.5
Decile 5	3022	33582.56	29175.56	-44563.18	290128.2
Decile 6	3672	34647.66	29527.02	-45611	234489.1
Decile 7	2609	36185.36	32120.84	-45611	426721.8
Decile 8	3519	38049.76	34102.01	-49637.61	632140.7
Decile 9	2868	41519.79	37079.16	-49695.68	379481
Decile 10	3434	52837.83	46449.69	-54363.93	507986.1

Table 21: Mean annual subsidy value for each income decile adjusted for queue time,rent and other control variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Decile 1	2754	1219.374	19735.33	-108322.5	98249.06
Decile 2	2815	371.005	20489.86	-81486.36	95509.28
Decile 3	2850	-1482.481	20283.66	-86341.33	80706.43
Decile 4	2930	-928.96	20655.02	-95123.35	117623.7
Decile 5	3022	-1010.155	21368.65	-95433.48	135432.4
Decile 6	3672	-1129.122	21404.67	-77327.31	112819.1
Decile 7	2609	-1290.317	22362.43	-127259.7	216027.7
Decile 8	3519	-622.367	23975.94	-117227.5	396995.6
Decile 9	2868	174.592	24611.07	-98737	199237.2
Decile 10	3434	4309.561	30501.94	-172437.6	277676.7

VARIABLES	Public Log price	Private Log price
Log adj. Income	0.0962***	0.0803***
	(0.00700)	(0.0111)
Year Queued	0.0535***	0.0607***
	(0.000758)	(0.000971)
Log adj. rent	0.864***	1.134***
	(0.0210)	(0.0217)
Rooms	-0.0100	-0.101***
	(0.00995)	(0.0102)
Floor	-0.0173***	0.00912***
	(0.00166)	(0.00203)
Surface Area	-0.0157***	-0.0148***
	(0.000674)	(0.000568)
Area Observations	0.00194***	0.00151***
	(5.55e-05)	(7.99e-05)
Constant	14.57***	12.61***
	(0.170)	(0.183)
Observations	18,557	11,702
R-squared	0.439	0.503

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 22: Regression on apartment values unadjusted for differing price increases

Table 23: Annual subsidy as per cent of rent paid

Income deciles	Obs	Mean	Std. Dev.	Min	Max
Decile 1	3567	59.219	55.432	-80.501	752.673
Decile 2	4073	56.496	52.389	-70.345	301.006
Decile 3	2826	57.337	52.548	-80.951	327.999
Decile 4	5201	55.581	51.989	-76.228	364.034
Decile 5	2230	55.308	53.873	-76.228	399.884
Decile 6	3830	55.495	54.476	-76.228	766.603
Decile 7	4642	54.828	52.477	-84.855	379.179
Decile 8	3237	54.837	55.057	-80.648	551.586
Decile 9	3951	53.104	51.718	-69.857	371.702
Decile 10	4198	57.636	51.758	-71.61	813.433

VARIABLES	(1) Log adj. Price	(2) Log adj. Price	(3) Log adj. Price
	One Room	Two Rooms	Three Or More Rooms
Years queued	0.0373***	0.0281***	0.0219***
	(0.000682)	(0.000403)	(0.000354)
Log adj. income	0.0627***	0.0302***	0.0212***
	(0.00577)	(0.00399)	(0.00363)
Log adj. rent	0.338***	0.433***	0.515***
	(0.0131)	(0.00954)	(0.00856)
Floor	0.000660	-0.00324***	-0.000398
	(0.00126)	(0.000902)	(0.000728)
Surface area	0.0196***	0.00988***	0.00505***
	(0.000416)	(0.000254)	(0.000132)
Area observations	0.00109***	0.00109***	0.000770***
	(5.36e-05)	(3.65e-05)	(2.92e-05)
Private landlord	0.0215***	-0.000762	0.00117
	(0.00549)	(0.00363)	(0.00326)
Constant	9.962***	10.04***	9.788***
	(0.112)	(0.0811)	(0.0734)
Observations	6,210	12,832	11,314
R-squared	0.743	0.535	0.669

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 24: Regression on apartment value for different number of rooms in the apartment

VARIABLES	(1) Log Subsidy Value One Room	(2) Log Subsidy Value Two Rooms	(3) Log Subsidy Value Three Or More Rooms
Years queued	0.110***	0.0841***	0.0642***
	(0.00275)	(0.00162)	(0.00199)
Log adj. income	0.167***	0.0902***	0.0573**
	(0.0258)	(0.0172)	(0.0261)
Log adj. rent	-0.954***	-0.882***	-0.223***
	(0.0663)	(0.0422)	(0.0602)
Floor	0.00462	-0.00251	0.0150***
	(0.00619)	(0.00416)	(0.00495)
Surface area	0.0581***	0.0293***	0.0135***
	(0.00210)	(0.00116)	(0.000737)
Area observations	0.00247***	0.00271***	0.00234***
	(0.000224)	(0.000146)	(0.000189)
Private landlord	0.198***	0.0687***	0.0325
	(0.0287)	(0.0167)	(0.0271)
Constant	16.07***	17.87***	13.51***
	(0.524)	(0.351)	(0.542)
Observations	5,098	11,579	2,574
R-squared	0.352	0.253	0.348

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 25: Regression on subsidy value for different number of rooms in the apartment