

**EFFICIENCY IN HOUSING MARKETS:
DO HOME BUYERS KNOW HOW TO DISCOUNT?**

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Abstract

We test for efficiency in the market for Swedish co-ops by examining the negative relationship between the sales price and the present value of future rents. If the co-op housing market is efficient, the present value of co-op rental payments due to underlying debt obligations of the cooperative should be fully reflected in the sales price. However, we find that, on average, a one hundred kronor increase in the present value of future rents only leads to a 45 to 65 kronor reduction in the sales price; co-ops with higher rents are thus relatively overpriced compared to those with lower rents. Our analysis indicates that pricing tends to be more efficient in areas with higher educated and wealthier buyers. By relying on cross-sectional relationships in the data, our results are less sensitive to transaction costs and other frictions than time-series tests of housing market efficiency.

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I. Introduction

For the majority of households, the purchase of a home is the largest financial decision of their lives. One may therefore assume that housing market transactions are conducted by agents who have carefully evaluated all available information and that the resulting prices reflect that information. However, there are fewer professional investors in a housing market than in a typical financial market, which may lead to less informationally efficient prices if the average home buyer cannot fully process all available information. In addition, high transaction costs and other market frictions, such as transfer taxes and inherent inertia in the market, may also prevent people from timing the market or otherwise making full use of their information. This last point makes traditional time-series tests of housing market efficiency difficult to interpret (e.g. Case and Shiller 1989, 1990).^{1,2}

In this paper, we present a simple test of efficiency in the market for cooperative housing in Sweden. Cooperatives are distinct from condominiums in that the purchaser of a unit in a cooperative housing association is formally buying a share in the cooperative, along with the non-time-restricted right to occupy the unit, i.e. the actual apartment. As is typical for condominiums, owners of a co-op unit must also pay a monthly rent. The rent is comprised of maintenance fees and the capital costs attributed to the cooperative's debt. The latter derives from the fact that the formal owner of a co-op unit is the cooperative association; the cooperative can have its own debts, which are serviced through the collection of rents from the members of the cooperative, i.e. the indirect owners of the cooperative apartments. These implicit interest

¹ Meese and Wallace (1994) try to get around the issue of market frictions by considering tests of efficiency in the long-run, where short-run market frictions should play no role. However, their approach is essentially based on comparisons between price and rent indices, which for obvious reasons are not based on the same housing units or units that necessarily have comparable characteristics.

² Other related studies include Case and Quigley (1991), Guntermann and Norrbin (1991), Gatzlaff (1994), Berg and Lyhagen (1998), Englund et al. (1999), Hill et al. (1999), Malpezzi (1999), Hwang and Quigley (2002, 2004), Gallin (2005), and Rosenthal (1999).

payments in the monthly co-op rents are on top of any direct mortgage service obligations that the home buyer may have incurred. Thus, only part of the true cost of owning a co-op unit is reflected in the actual sales price; the remaining cost is reflected in the monthly rent. The total value of a co-op unit can therefore be expressed as the sum of its sales price and the discounted value of the cooperative financing component of the monthly rent payments, i.e. rent excluding the maintenance fee component.

This simple present value relationship provides the starting point for our analysis. In particular, if markets are efficient, there should be an inverse one-to-one relationship between prices and discounted rents. That is, if the present value of rents goes up by one unit, prices should decrease by one unit. This relationship should hold for any co-op being sold. For instance, consider two otherwise identical co-ops, one with a monthly rent of 2,000 Swedish Kronor (SEK) and the other with a monthly rent of 3,500 SEK. This implies a difference of 18,000 SEK in annual rent payments. Assuming an effective discount rate of 5 percent, the present value of the difference in future rent payments is 360,000 SEK. Thus, the apartment with the lower rent should have a 360,000 SEK higher sales price.³

Thus, using transaction-level data of individual co-op sales, we can test for market efficiency in the cross-section rather than the time-series dimension, thereby avoiding most of the difficulties caused by market frictions and inertia. Of course, by relying on a cross-section of transactions, we need to control for the individual characteristics of the transacted co-ops. We do so by using a rich data set that includes more than 30,000 transactions of Swedish co-ops from 2002 to 2005.

³ Rent payments such as these are realistic for an apartment of approximately 70 square meters, which on average sells for 1.2 million SEK in our sample.

Using data from the Swedish market provides several potential benefits. First, co-op transaction costs in Sweden are very low. Second, co-op ownership is the only way to own an apartment in Sweden. Thus, the Swedish co-op market is likely to be more representative of the overall owner-occupied housing market than it may be in the U.S., where co-ops are rare except in certain cities (Schill et al., 2004). Third, strict building codes and a narrow income distribution make Swedish apartments very homogeneous. This makes it much easier to control for unobservable characteristics in the data.

Our empirical analysis is based on hedonic price regressions that relate co-op sales prices to future discounted rent payments. The discounted value of the rent takes into account Sweden's 30 percent tax deduction on mortgage interest payments and is computed using the five-year mortgage rate on the date of the transaction. In our preferred specification, we control for (i) apartment characteristics, e.g. size and the number of rooms, (ii) location, through the use of parish and neighborhood fixed effects, and (iii) national and local housing market trends.⁴

If markets were efficient, then the regression coefficient on future discounted rent payments should equal minus one, fully reflecting the cost of a higher rent in the sales price. However, the empirical results show that an increase in discounted rents by 100 SEK only leads to a decrease in price of about 45 SEK. On average, co-ops with high rents are thus relatively over-priced. We consider the sensitivity of this baseline finding to changes in our assumptions about the amortization rate, future interest rates, and capital gains. For example, specifications which allow the cooperative to amortize its loans at a 1 percent annual rate yield a coefficient on discounted rent of -0.64; this is still far from efficient. Additional sensitivity analyses also indicate that there is little variation in these results over the sample period, and that they are not

⁴ Linneman (1986) also relies on hedonic price regressions to determine what the 'fair' value of houses are and classifies the market as inefficient if the pricing errors based on the fitted hedonic regression exceed the transaction costs in the market for a substantial number of observations.

being driven by the relatively low interest rates that prevailed during the last few quarters of our sample.

The only way to reconcile prices and rents, as predicted by the efficient market hypothesis, is for buyers to have extremely risk-averse beliefs of the future path of the interest rate while assuming that rents will stay almost fixed. This explanation is unlikely to be convincing both because of the very high implicitly needed future interest rates and because rents in general also go up if interest rates rise, since the rents themselves reflect debt service payments on loans. It is thus hard to reconcile the empirical findings with an efficient market.⁵

Finally, we also analyze whether these empirical results are consistent across the population of home buyers. Specifically, we estimate the hedonic pricing model for each parish separately. Interestingly, we find strong evidence that the degree of market efficiency varies between parishes and that it does so in a manner that is systematically related to socio-economic variables. On average, parishes with the highest degree of market efficiency are also those with the highest proportion of university educated inhabitants and the highest incomes and wealth; however, for most parishes, the null of market efficiency can still be rejected. These findings also line up well with one's intuition regarding who would be the 'sophisticated' buyer.

Our findings are in line with most of the time-series results reported in the literature, which typically show that house prices do not follow random walks and that there may be profit opportunities for buyers who time the market (e.g. Case and Shiller, 1989, 1990). However, our results are less sensitive to transaction costs and thus provide much stronger evidence against fully efficient prices in housing markets than those previously presented.

⁵ The five year fixed-rate mortgage interest rate that we use should be a conservative (high) estimate of the discount rate facing the home buyer at the time of the purchase, given that most home buyers in Sweden take at least a part of their loans with a floating rate. For instance, according to the mortgage lender SBAB's website (www.sbab.se), less than 10 percent of their loans have interest rates that are fixed for five or more years; in fact, 69 percent of their loans have floating rates; these statistics are for July 2006.

The rest of the paper proceeds as follows. Section II describes the characteristics of the Swedish co-op housing market and Section III outlines the econometric model and discusses the potential identification issue of omitted variables. Section IV describes the data. The main empirical results are presented in Section V and Section VI analyzes the sensitivity of our results to assumptions about rents, discount rates, and amortization. Section VII explores whether our findings of inefficiency are heterogeneous across parishes and socioeconomic characteristics. Section VIII concludes and discusses potential policy applications.

II. The Swedish Cooperative Market

Overview

Cooperative (co-op) ownership is the only way to own an apartment in Sweden; condominiums do not exist as an alternative. Apart from single family houses, co-ops are therefore the only other form of owner-occupied housing, and in central areas of most cities, the only alternative to rental apartments. The purchase of a co-op unit entails ownership of a share of the cooperative, as well as membership in the cooperative association. The share ownership is not time-restricted in any sense, and will only be returned to the cooperative in the rare cases when an owner must sell and cannot find a buyer. In contrast to the condominium form of ownership, a share in a co-op does not convey actual property rights over the apartment unit, and purchases of co-op apartments are not formally regarded as real estate transactions. In practice, the main implications are that co-ops have less value as collateral and, in the unlikely event that the cooperative goes bankrupt, the share-holders would lose their rights to the apartments. The shareholders in the co-op are, however, free to renovate and otherwise modify their apartments in the same manner as an owner of a condominium would be.

Formally, a new owner of a share in a co-op needs to be approved by the co-op board, but this is primarily a formality and rejections tend to be rare. However, the co-op board in Sweden does commonly exercise its powers with regards to renting out co-ops to a third party. As a general rule, co-ops are intended to be occupied by their actual owners and cannot be rented out without board approval. There are some time limited exceptions, such as studying or working abroad for a fixed period of time, but it is usually difficult to get permission for more than a few years. The motivation behind these rules is that the co-op is not intended as an investment vehicle but as an owner-occupied form of living. From the perspective of the current study, this means that although there will always be some speculators in the market, e.g. co-ops can always be rented out without board approval, the vast majority of observations in the data represent purchases by people intent on occupying the unit themselves.⁶

Rent Determination

The cooperative association faces two sorts of costs. First, there are the costs of maintaining all interior and exterior common areas as well as other maintenance costs that may be shared among the members, such as water and heat, which may be included in the rent because of district heating. Second, the cooperative as a whole may have loans that need to be serviced. These costs are met by collecting rents from the association members; the rents are based on the size of their shares in the cooperative and typically are fairly linear functions of apartment size. The per square meter maintenance fee component of the rent generally does not vary much between different co-op associations, but the mortgage portion can vary substantially depending on the size of the cooperatives' loans.

⁶ Turner (1997) provides some additional information on the cooperative housing market in Sweden.

When a co-op is initially formed and the shares are sold, either by a residential developer or through a conversion of rental units to co-op units, the founders can decide how much of the total cost of the shares will be paid upfront by the buyers and how much of it will be financed by mortgages taken out by the cooperative itself. If the cooperative opts to finance a larger amount, then higher monthly rents are necessary. *Ceteris paribus*, higher rents should therefore imply a lower price.⁷

It should be stressed that given the size of an apartment's share in the cooperative, the rent will not be affected by individual characteristics of the apartment. That is, if an apartment gets renovated by the current owner, the increased standard of the apartment will only be reflected in the price of the apartment when it is next sold, not in its rent.⁸

Market Characteristics

In contrast to the U.S. housing market, the Swedish housing market is generally characterized by low transaction costs and few market frictions; this is particularly true for the co-op market. A purchaser of a co-op in Sweden faces virtually no transaction costs: there are no transfer fees or taxes and no fees for a formal title to the apartment; the realtor fees are paid by the seller; and there are minimal fees to obtain a mortgage (less than 1500 SEK). Overall, frictions in the market are also small. For instance, sales contingent on the seller finding a new

⁷ It is not clear what determines the proportions in this initial split between the upfront cost and the financing through cooperative loans that are paid for through future rents. Indeed, given that the cooperative generally enjoys less advantageous tax deductions on its loans, it would typically be more efficient for the individual buyers to pay the total value of the co-op unit directly and carry all of the capital costs in the form of private mortgages. We briefly return to this puzzle in the conclusions.

⁸At times, the cooperative as a whole conducts major renovations, such as changing the electricity or sewage systems in the entire building. Anticipated rent increases associated with such renovations could bias our results if the buyers of a certain co-op perceive the long-run rent as higher than what we observe. Cooperatives, however, do typically have funds put aside over time to at least partially cover the costs of future renovations; thus, many anticipated renovations should cause only minor, and most likely transient, changes in rents. Unanticipated renovations that lead to increases in the rents cause no bias, of course.

residence, which is common in the U.S. and U.K. housing markets, are non-existent. Given the legal culture in Sweden, the amount of paperwork involved is also minimal and generally based on standard contracts that cannot be altered. The seller does incur some transaction costs in the form of a realtor's commission and potential capital gains taxes, unless the revenue from the sale is used to purchase a new residence. However, from the perspective of the current study, where the focus of interest is on efficient price formation in the cross-section, rather than across time, the potential transaction costs faced by the seller should not affect the results.

In summary, the Swedish co-op market suffers from few transaction barriers, both in absolute terms and relative to many other housing markets. There is thus great potential for this market to function in an efficient manner. However, unlike a frictionless financial market, there is a dearth of professional investors operating on the market, which may affect price setting in the market, a point to which we return later.

III. Modeling the Relationship between Prices and Rents

The purpose of this paper is to estimate the degree to which differing rents across apartments are accounted for in the sales prices of co-ops. The basic idea is that given two identical apartments with different rents, the difference in price between the two apartments should equal the difference between the present values of all future rent payments. To account for the fact that apartments differ in dimensions other than rents, we rely on hedonic price regressions and control for a variety of apartment characteristics.

Theoretical Motivation

As discussed previously, the rent on a co-op is comprised of a maintenance fee component and a capital cost component, which covers the cooperatives' financial costs in terms of mortgages and loans. In effect, a co-op purchaser takes on a share of the cooperatives' debt obligations, commensurate with the size of his share in the cooperative. Thus, the true price, or intrinsic value, of the co-op is actually the sum of the sales price and the present value of this future stream of capital cost payments. Consequently, the sales price should equal the intrinsic value less the present value of the capital cost payments.

In a hedonic pricing formula, this relationship would be captured as follows,

$$p_i = \theta \text{PV}(C_i) + X_i\beta + \varepsilon_i \quad (1)$$

with $\theta = -1$. Here, p_i is the sales price, C_i is the capital cost component of the rent, the vector X_i includes other relevant characteristics of the co-op, and ε_i is the error term; PV denotes present value.

Empirical Implementation

Thus, the aim of this paper is to test whether the coefficient θ in equation (1) is significantly different from negative one. To bring this hedonic pricing formula to the data, we must deal with the fact that the capital cost component of the rent is not directly observed. Rather, we only observe the total rent, i.e. maintenance plus capital costs. So, in order to justify the use of total rent rather than the capital cost component, we make two fairly weak assumptions. Specifically, we assume that the utility or value of the services rendered to the co-op owner from the maintenance fee does not vary between co-ops and that the maintenance fee per square meter is equal across cooperatives. That is, we assume that the maintenance part of

the rent provides the basic services needed to maintain the buildings, but adds no additional utility above this base level. This is a fairly weak assumption given the nature of most Swedish housing cooperatives. There are typically no common area rooms or other elements, such as pools or doormen, which would add to the maintenance fee but at the same time provide additional utility to the home-owners.⁹ Under these two assumptions and a common discount rate for all buyers, it follows that the difference between the present value of the total rent and the present value of the capital cost component is constant across co-op transactions once size is controlled for; hence, θ can be consistently estimated. As our data set spans nearly four years, the discount rate is not identical for all transactions; therefore, we also include the discount rate itself as a control variable.

We calculate the present value of future discounted rents as $Rent_i/k_i$, where k_i is the discount rate given by

$$k_i = (1 - \tau)m_i + a_i - \pi_i \quad (2)$$

and τ is the tax rate at which mortgage payments are deductible and equal to 30 percent, m_i is the mortgage rate at the time of transaction i , a_i is the amortization rate, and π_i is the expected capital gains on the apartment.¹⁰

Equation (3) presents the basic specification taken to the transaction-level data. The dependent variable, p , is the sales price for transaction i in quarter t , parish j and zip code k .

⁹Even if the second assumption does not hold, the pricing relationship with $\theta = -1$ should still be true as long as the first assumption holds. However, this would capture a somewhat broader relationship between prices and rents; that is, as long as higher rents do not provide higher utility, the differences in rents should be fully reflected in the sales prices.

¹⁰The maintenance fee part of the rent is likely to increase somewhat over time as the cost of maintenance increases in nominal terms. However, this does not affect the future discounted value of the capital cost component; inflation should therefore not be included in the discount factor.

$$p_{ijk} = \theta \left(\frac{rent_{ijk}}{k_i} \right) + X_{ijk} \beta + Q_t \gamma_t + P_j \delta_j + (P_j * T_t) \lambda_j + Z_k \varpi_k + \varepsilon_{ijk} \quad (3)$$

To consistently estimate the relationship between the price of an apartment and the present discounted value of its rent (θ), one must control for all characteristics which are correlated with both rent and price. We directly control for a number of observable and unobservable characteristics. Specifically, we control for apartment characteristics, such as size, number of rooms, floor, building age, and whether or not heat is included in the rent, as well as the mortgage rate facing the purchaser (X). We also control for unobservable geographical or neighborhood characteristics, using parish and zip code fixed effects (P and Z), as well as trends in prices and rents using quarterly dummies (Q) and parish specific time trends ($P*T$). In Sweden, a parish is comparable to a county; zip codes are quite small, ranging from a few hundred to a few thousand residents.

Omitted Variables

Of course, given the cross-sectional nature of our analysis, one must address the concern of omitted variable bias. If a variable that is correlated with both prices and rents is not included in our specification, our estimate of the rent coefficient would be biased. In particular, an omitted variable that is positively correlated with both price and rents would bias our results away from market efficiency and towards a coefficient of zero.

The most obvious omission is probably a measure of the overall standard of the apartment. However, there is no strong reason to believe that rents and standard are correlated. In fact, a review of co-op advertisements provides little evidence in support of such a relationship. Specifically, idiosyncratic upgrades, such as a kitchen renovation, would be reflected in the price of an apartment but not in the rent. Not all variation in standard is

idiosyncratic across units. It is certainly feasible that some cooperatives with an overall greater standard have a higher level of debt. To the extent that age and standard are correlated, however, we can indirectly control for systematic variation in standard by including building age in our analysis. We should also stress that strict building codes in conjunction with thin tails in the income distribution contribute to fairly homogeneous housing standards in Sweden. Indeed, it is no stretch to say that there are no ‘bad’ apartments in Sweden. Omitting information about an apartment’s level of standard should thus be less crucial here than in many other housing markets.

Other omitted variables are more subtle. For instance, many rental buildings have been converted into cooperatives in recent years; this occurs through a process where the tenants in the rental units buy the building and form a cooperative. If some tenants elect not to buy their apartments, those units remain as rental units owned by the cooperative. The cooperative typically plans to sell these apartments as co-ops once the current tenants give up their rental contracts. Such sales can provide the cooperative with large one-time profits that may be used to pay off their debts and lower rents. Not controlling for future sales could bias the results away from efficiency since expected long-term capital costs of the cooperative may be smaller than what we infer from the current rent level.¹¹

Since our data does not indicate whether a cooperative has rental apartments remaining, we obtain additional information from annual statements for a subset of 125 cooperatives in

¹¹Another potential omitted ‘variable’ is that high rents, and consequently large debt levels, might in some circumstances send a signal that the cooperative is poorly managed or in some economic distress. If high rents were indeed a signal of economic problems for the cooperatives, one would expect low rent apartments to be relatively more attractive than high rent apartments; that is, the coefficient in front of the discounted rent, θ , should be less than minus one in an efficient market. Given that we consistently find θ to be greater than minus one in the empirical results, we do not investigate this conjecture further. However, it potentially adds to the strength with which we reject the efficient market hypothesis.

Göteborg.¹² We find that a number of the newer cooperatives do own rental units and that there are instances where sales of these units lead to a substantial amortization of their loans. Overall, 15 of the 125 cooperatives amortized more than 5 percent of their loans; in eight of those cases, it was explicitly stated that apartments had been sold. Yet, only three of those 15 cooperatives lowered their rents as a consequence. Indeed, many new cooperatives, which are the ones that tend to have rental units left to sell, often seem to face fairly large renovation costs, which at least partially offset the gains from their sales of rentals.¹³

As an attempt to control for such omitted variables, we also estimate equation (4), which aggregates the data up to the parish-level for each quarter.

$$\overline{p}_{ij} = \theta \overline{\text{PV}}(\overline{\text{rent}}_{ij}) + \overline{X}_{ij}\beta + Q_t\gamma_t + P_j\delta_j + (P_j * T_t)\lambda_j + \varepsilon_{ij} \quad (4)$$

We include the same set of observable controls, measured as the parish average for each quarter, as well as parish dummies and parish-specific time trends. Averaging the data in this way washes out most of the idiosyncratic differences across apartments. Thus, while we still cannot control directly for apartment standard, for instance, the unobservable of concern is now average standard across parishes. As it is highly unlikely that average parish standard changes during the four years of our data, this unobservable standard will be wiped out with parish fixed effects.

¹² The annual statements were obtained from the website of the realtor firm Ahre, www.ahre.se. Most of the statements cover either the year 2004 or 2005. In cases where there were multiple years available for one cooperative, we recorded the results from the most recent statement.

¹³ In addition, we merge information from the annual statements into our transaction data; this leaves us with a data set of more than 900 observations. Actually controlling for whether the apartment is from a co-operative with any rental units left to sell has no effect on the estimated discounted rent coefficient. This sub-sample is fairly representative, as the estimated rent coefficient is quite comparable to that found when using the entire sample.

IV. Data

We obtain data on over 30,000 transactions of Swedish co-ops between January 2002 and September 2005 for the three largest cities in Sweden: Stockholm, Göteborg, and Malmö. The data come from a company called Värderingsdata AB, which collects data on all co-op transactions conducted by members of Svenska Mäklarsamfundet (the Swedish realtor association), as well as by Föreningssparbankens Fastighetsbyrå and Svensk Fastighetsförmedling, which are the two largest realtors on the market. The data is believed to cover approximately 70 percent of all co-op transactions that occur in Sweden.

There are no indications that the data are not representative of co-op transactions in Sweden. The only obvious selection bias is a truncation of the very high end of the market. This is probably most relevant for Stockholm's wealthiest neighborhoods, where the co-op market is dominated by a handful of realtors dealing almost exclusively in high-end properties. However, unless one is primarily interested in price formation at the most expensive end of the market, these omissions are not likely to affect the results and generalizability of our study.

For each transaction, the following data are recorded: the transaction date, the actual sales price, the monthly rent, the size of the apartment measured in square meters, the number of rooms, the apartment's floor number, the build year, and whether heating is included in the rent.¹⁴ In addition, the address of the apartment, including the zip code, and the name of the co-op in which it is sold are reported. The zip code allows us to identify in which parish and city the apartment is located.

Table 1 presents summary statistics for the entire sample. The average price of co-ops sold in the entire sample is 1,250,685 SEK; at an exchange rate of 7.5 SEK per U.S. dollar, this

¹⁴ In Sweden, 'number of rooms' refers to the number of rooms besides the kitchen and bathroom. So, a one-room apartment is a studio, a two-room apartment is a one bedroom, etc. Number of bathrooms is not reported in the data; but, this is largely a reflection of the lack of emphasis placed on bathrooms in the market.

is approximately \$167,000. Prices vary substantially across the three cities, ranging from an average of 1.6 million SEK in Stockholm to 1.0 million SEK in Göteborg and just 0.7 million SEK in Malmö. The average annual rent is 37,629 SEK across all cities; there is much less variation in the annual rent across cities than there is in the price. To calculate the present value of future rent payments, we rely on the mortgage rate as of the transaction date. This is measured as the average of the five-year rates from three different lenders (SBAB, Nordea, and Stadshypotek); the average mortgage rate faced by purchasers in our sample is 4.8 percent. Assuming no capital depreciation and no amortizations, but allowing for tax deductions, the average present discounted value of annual rent payments is 1,150,926 SEK. Thus, the present value of future rent payments is not an inconsequential amount; on average, it almost equals the purchase price. Though we do not directly have data on the size of the capital component of the rent, we estimate it by subtracting out 350 SEK per square meter from the annual rent, which is a reasonable estimate of the maintenance fee. The average discounted value of the capital component of the rent is 448,351 SEK, which is still almost 40 percent of the average sales price.

Figure 1 plots average transaction price and average discounted annual rent, both with and without maintenance costs, for each quarter from January 2002 through September 2005. Substantial increases are seen in each data series. Average transaction prices increased more than 35 percent over this time period while average discounted rent streams actually increased by more than 80 percent. However, the increase in the discounted annual rent can be attributed to changing discount rates, which decreased from 6.7 percent in the first quarter of our study to 3.6 percent, on average, in the final quarter.

The average apartment in the entire sample is 66 square meters (approximately 700 square feet); two room apartments are the most common. Overall, 73 percent of the co-ops

include heat in the rent. Seven mutually exclusive variables are created to indicate the age of an apartment, where the age is defined to be the transaction year minus the build year. Overall, 5.2 percent of the units are less than 10 years old. About two-thirds of the units, however, are more than 50 years old. Note that the age of the building and the age of the cooperative are generally not the same; however, we lack data on the year in which the cooperative was founded.

V. Baseline Results

In this section, we present results when the discount factor is set equal to $(1-\tau)m_i$, where m_i is the five year mortgage rate as defined above. The amortization rate and expected appreciation rate are both set to zero. In the subsequent analyses, we explore different modifications to this baseline discount factor.

Transaction – Level Analysis

Table 2 presents the results of estimating equation (3). The coefficient on the discounted annual rent is displayed in the first row. A coefficient significantly different than -1.0 provides evidence of market inefficiency in the sense that co-op purchasers do not properly discount the rent. For instance, if the rent coefficient is equal to -0.5, then for every 100 SEK increase in discounted rent, the transaction price only decreases by 50 SEK. Column (1) in Table 2 shows the result from simply regressing transaction price on discounted annual rent; this yields a rent coefficient that is actually positive (0.38) and significant; this is not surprising given that larger apartments have greater shares of the cooperative and, consequently, higher rents. As seen in column (2), including a second-order polynomial of apartment size yields a negative relationship between discounted annual rent and transaction price.

To account for the fact that prices and discounted rents have been trending upwards over the course of the sample period, column (3) includes a set of quarter dummies; this brings the rent coefficient to -0.75. Column (4) adds parish dummies to control for unobservable community or geographical characteristics that are fixed within a parish.¹⁵ To control for varying price trends across regions, column (5) includes parish-specific linear time trends. Controlling for both unobservable fixed parish characteristics and parish-specific trends yields a rent coefficient of -0.51. Column (6) of Table 2 controls for apartment specific characteristics, such as number of rooms, floor, whether heat is included in the rent, and age. Though the estimated coefficients for the apartment characteristic variables are themselves highly significant, there is no change in the rent coefficient. Similarly, controlling for the discount rate faced by the purchaser in column (7) yields little change in the estimated rent coefficient. Lastly, column (8) adds zip code fixed effects into the specification to capture unobservable neighborhood characteristics.

When the full set of controls is included, the estimated coefficient on the discounted annual rent is -0.45. As the standard error is just 0.02, the 95 percent confidence interval for the rent coefficient is from -0.49 to -0.41.¹⁶ On average, increasing the discounted annual rent by 100 SEK decreases the transaction price by only 45 SEK. Thus, the results so far strongly reject the efficient market hypothesis.

¹⁵ Table 1 presents within parish standard deviations for each of the variables; i.e. the standard deviation after subtracting the parish mean from each observation. While there is slightly less variation within parishes than in the entire sample, there is still a sufficient amount of variation for identification. Similarly, though not presented here, a substantial amount of variation remains when looking at the within zip code standard deviations for each variable.

¹⁶ Throughout the paper, all transaction-level analyses use robust standard errors that are clustered at the parish-level.

Parish – Level Analysis

The transaction-level analysis presented above estimates the relationship between discounted rent and price while controlling for observable apartment characteristics as well as unobservable neighborhood and community characteristics. In an attempt to deal with potential omitted variable bias, Table 3 presents the results of estimating equation (4), which aggregates the data up to the parish-level for each quarter. The full set of observable controls seen in Table 2 as well as quarterly dummies, parish fixed effects, and parish specific time trends are included in the parish-level estimation.

Once again, column (1) of Table 3 includes no controls and results in a discounted annual rent coefficient of -0.28; by averaging the observations in each parish, apartment size is at least partially controlled for. The remaining columns of Table 3 add in the controls in a manner parallel to that presented in Table 2. When the full set of controls is included in column (7), the estimated coefficient on the discounted annual rent is -0.62. Standard errors are somewhat larger here than in the transaction-level analysis, yielding a 95 percent confidence interval of -0.74 to -0.50. Overall, the transaction and parish-level analyses tell similar stories. Thus, given that this aggregation results in a large decrease in sample size and, consequently, precision as well as an inability to control for zip code characteristics, we only present transaction-level results for the remainder of the paper.

VI. Robustness – Relaxing the Discount Rate Assumptions

The empirical results presented in the previous section are based on the assumption that both rent and discount rates remain at current values in all future periods. Here, we discuss the effects of relaxing these assumptions in a manner consistent with what we observe in the data.

Amortization and Rent Changes

For the purpose of this study, we are primarily interested in the changes in the capital cost component of the rent since changes attributable to changing maintenance costs would not affect the analysis.¹⁷ The average annual increase in rent per square meter observed in our data is 1.3 percent. Though this is in line with rent changes being driven by inflation in maintenance costs, one cannot discern from our data whether capital costs have changed.

To get a sense of the dynamics of the capital cost part of rents, we return to the annual statements from 125 cooperatives in Göteborg and record the amortization rate of their loans as well as the change in overall rents. We focus on the amortization rate since this should be the primary determinant of the capital costs of the cooperative in the long-run. The results are shown in Table 4. The average change in overall rent for the 125 cooperatives is 1.2 percent, which is very similar to that found in our original data set. As is seen from the percentiles of the rent changes, very few cooperatives lower their rents, although more than half keep their rents fixed for the year of the annual statement. The average amortization rate is 1.7 percent, although this may be somewhat misleading since the median rate is only 0.53 percent. The high average is driven by a few large amortizations, which were primarily the results of some windfall gain for the cooperative, such as the conversion and sale of previous rental apartments. These high amortization rates are therefore almost exclusively one time events and do not represent long term averages. The final row in the table gives the statistics for those cooperatives that amortized between 0 and 5 percent of their loans, and for which the average amortization rate is 0.71

¹⁷ Under the assumption of identical maintenance costs across cooperatives, an increase in this common cost would not affect our results.

percent. Based on a reading of the annual statements, we believe that this latter number gives a better estimate of the long-term average amortization rate.

Table 5 shows the results when an amortization rate of 1 percent is accounted for in the discount formula shown in equation (2); the discount formula is otherwise identical to that used previously. When all controls are included, the coefficient on future discounted rent equals -0.64. The corresponding result in Table 2, without amortization, is -0.45. If we instead set the amortization rate to 2 percent, the coefficient drops to -0.82; however, we feel that such a rate is unrealistically high given the evidence seen in the annual statements. Accounting for amortization thus pulls the results some way towards market efficiency, but with a realistic discount rate of 1 percent, there is still a large discrepancy.

Interest Rate Changes

The interest rate used in the discount formula obviously has a large effect on the present value of the discounted rent. The interest rate is fairly low during parts of the sample, particularly towards the end (3.6 percent during the last quarter); this is most likely well below what can be expected over the long-run. Thus, there might be some concern that our findings can be explained by expectations about interest rates increasing in the future, which would reduce the present value of future rent payments.

A first diagnostic of the validity of these concerns is to see if the rent coefficient changes dramatically over the sample period. If the evidence of market inefficiency is due to a failure to account for expectations about high future interest rates, we would expect the rent coefficient to be closer to efficiency at the beginning of the sample, where the interest rate is closer to a long-run average. Estimating equation (3) quarter by quarter indicates that there is some small

variation in the rent coefficient; however, it does not appear to be in any way systematic over time. Thus, the results are not driven by lower discount rates at the end of the sample.¹⁸

Alternatively, we can estimate the implied interest rate for each quarter that is consistent with market efficiency. That is, we set $\theta = -1$, and treat the discount rate as the free parameter to be estimated. We still assume that a 30 percent tax-deduction is taken into account, but that there is no amortization. For each quarter, Figure 2 plots the actual five-year rate as well as two estimates of the implied interest rate. The first estimate shows the implied interest rate that would have to prevail in *all* future periods in order for market efficiency to hold. The second estimate is the implied rate necessary in all periods after the first five years, assuming that the current five-year rate is used to discount during the initial five years. On average, the implied rate is about 3 percent higher than the five-year mortgage rate in each quarter, and ranges from about 10 percent in the first quarter to 7 percent in the last. The implied interest rate when the current five-year rate is used for the first five years is substantially higher and varies between 16 and 10 percent.

Though five-year fixed rate loans are available, many home buyers still choose floating interest rates. It is therefore reasonable to assume that most of the uncertainty (and risk-aversion) regarding future interest rates is beyond the five-year horizon; that is, we can view the five-year rate as a conservative (i.e. high) expectation of rates for the first five years. Otherwise, the fixed rate loan would be more frequently used. Based on the implied interest rate beyond the five year horizon, it is clear that home buyers would have to have very risk-averse beliefs regarding the path of future interest rates in order to justify the lack of market efficiency found thus far. This would also be true if one allowed for amortization, although somewhat less extreme expectations are needed.

¹⁸ Though not presented here, these results are available from the author upon request.

Future increases in the interest rate are likely to be associated with increases in the capital cost part of the rent, since this also reflects interest rate payments. Thus, future increases in the interest rate are likely to be more or less offset by increases in the rent, leaving the present value of future discounted rents fairly unchanged. Consequently, our analysis may be less sensitive to changing interest rates than it appears at first glance.¹⁹

Capital Gains

The only parameter in the discount formula left to consider is the capital appreciation rate, π_i . So far, we have assumed zero capital gains because π_i reflects buyers' expectations about the market in general and is hard to measure. From the above discussion, it is quite clear that π_i needs to be negative to get closer to market efficiency; that is, a price decrease would have to be expected. Since co-op prices increase substantially over the sample and the market can justly be characterized as booming, it does not seem likely that buyers would expect their homes to decrease in value. Case and Shiller (1988) find from survey data that home buyers in boom markets tend to believe that further price increases are likely, which implies that π_i should actually be positive. Case and Shiller also document that most home buyers see their purchase as an investment and that the decision to buy was influenced by the possible capital gains. Lastly, note that modest expectations of a 1 percent capital appreciation rate would cancel out the effects of the 1 percent amortization rate discussed above. Expectations of larger capital gains would

¹⁹ Home buyers may of course base some of their decisions on worst-case scenarios. For instance, as indicated by a loan officer at Handelsbanken (a Swedish bank), most banks today require that borrowers can handle an interest rate of 7-8 percent in the future. This is not inconsistent with the implied interest rates necessary in all future periods estimated in the final quarters of our data. Thus, one can raise these worst-case calculations as a potential explanation for our findings of market inefficiency. However, a permanent shift to an 8 percent interest rate would also necessitate a higher capital cost component of the rent, which would once again more or less offset the increased discount rate. This leaves the worst-case scenario explanation of inefficiency somewhat unsatisfactory.

bring the rent coefficient even closer to zero than in the baseline specification reported in Table 2.

VII. Heterogeneity Across Parishes and Correlates of Efficiency

Thus far, our results indicate that, on average, co-op purchasers do not properly discount the annual rent. It is possible, however, that the co-op market is more efficient in some subgroups of the population compared to others; that is, certain types of purchasers may be more likely to appropriately discount.

To try to get at these issues, we estimate equation (3) separately for each parish. Each regression includes the full set of controls, except for zip code fixed effects, and takes into account both a 30 percent tax deduction and a 1 percent amortization rate. We present the results in Table 6; each row corresponds to a single parish and displays the discounted annual rent coefficient, standard error, and 95 percent confidence interval. While there are 77 parishes in Stockholm, Göteborg, and Malmö, we only present the results for those 70 parishes with 50 or more transactions in the sample. Bolded rows indicate that the confidence interval contains -1.0. As seen in Table 6, the estimated rent coefficient is significantly different from -1.0 in 56 of the 70 parishes. In addition, the median estimate of the rent coefficient is -0.35. There is also a fair amount of variation in the rent coefficient across parishes; the standard deviation of the estimates is 0.23.

What explains this variation in the estimated rent coefficient? Why do co-op purchasers in certain parishes behave in a relatively more sophisticated manner? For each parish, we obtained information about the age distribution, the amount of education, average income and

wealth as well as the income distribution.²⁰ Table 7 groups the parishes into two samples, most and least efficient, and compares the above described variables. The first four columns break the sample in half; that is, the most efficient parishes are those with rent coefficients below the median or closer to -1.0. The last four columns look at parishes in the most and least efficient quartiles.

Parishes which behave more efficiently have a significantly lower proportion of the population under the age of 19 and significantly higher proportion between the ages of 25 and 44. However, while these differences are significant, they are also relatively small and not economically significant. The differences in the education and income variables across the two groups, however, are both statistically and economically significant. On average, 16 percent more of the population has attended college in the relatively more efficient parishes; this education gap increases to 21 percent when comparing parishes in the top and bottom quartiles. In addition, average income and average wealth are significantly higher in the more efficient parishes; for instance, average net wealth, including the value of housing, is more than 200,000 SEK greater. This value doubles when looking at the top and bottom quartiles.

Thus, Table 7 indicates that there are significant differences in socioeconomic characteristics between parishes that, on average, more accurately discount the rent. In general, these parishes are more educated and have greater wealth and income. These findings line up well with one's intuition regarding who would be the 'sophisticated' buyer. They are also in line with recent results by Campbell (2006), who analyzes household decisions regarding financial matters. He finds that a minority of households make significant investment mistakes; this group tends to be poorer and less well educated than the majority of more successful investors.

²⁰ We are grateful to Lennart Flood for performing all calculations involving these variables, which are sourced from the Swedish Linda dataset.

An alternative explanation to this heterogeneity in the degree of market efficiency across parishes is liquidity constraints. That is, if an initial down payment is needed, home buyers with less wealth may be forced to buy co-ops with lower prices and higher rents. Though there is generally no set down payment required in Sweden, some mortgage lenders appear to recommend at least 5 percent. Although there is no way to directly test this hypothesis in our data, a simple example sheds some light on the potential role of liquidity constraints. Consider again the example presented in the introduction; i.e. two identical 70 square meter apartments, one with a monthly rent of 2,000 SEK and the other with a rent of 3,500 SEK. In an efficient market, there should be a price difference of 360,000 SEK between these two apartments, if the effective discount rate is 5 percent, including amortization and capital gains. Thus, the difference in a 5 percent down payment would be 18,000 SEK. The average sales price for a 70 square meter apartment in our sample is around 1.2 million SEK, which implies an annual mortgage payment of 42,000 SEK with a 5 percent interest rate and 30 percent tax deduction. Therefore, the 18,000 SEK down payment difference seems relatively insignificant. Given this fairly realistic example, it does not seem likely that liquidity constraints explain much of the variation in efficiency across parishes.

VIII. Conclusion

We test for market efficiency in housing markets using a new and novel approach. We capitalize on the fact that only part of the true price of a co-op is captured by the actual sales price, with the rest paid through monthly rents that reflect the underlying debts of the cooperative. There is thus a simple present value relationship between co-op sales prices and rents.

Using hedonic price regressions, we find that, on average, higher rents are not fully compensated by lower prices. Under realistic assumptions regarding future interest and amortization rates, a 100 SEK increase in the discounted value of future rent payments only yields a 45 to 65 SEK reduction in the sales price. Overall, there is very strong evidence that home buyers do not fully take into account the costs of monthly rent payments when purchasing a co-op.

Some quick calculations give an idea of the magnitude of the overall pricing error. Consider an apartment in a cooperative with loans of 5,000 SEK per square meter. This represents a capital cost of about 250 SEK per square meter per year and is close to the mean in the data if a maintenance cost of 350 SEK per square meter is assumed. If only about 50 percent of the capital cost is reflected in the sales price, the buyer of the co-op pays 2,500 SEK per square meter more than if the cooperative were debt free. With an average sales price around 18,000 SEK per square meter, this represents a pricing error of about 14 percent, or 175,000 SEK on a 70 square meter co-op.

Additional analyses show that the relationship between discounted rent payments and sales price is fairly heterogeneous across buyer groups. An analysis of the socio-economic characteristics of potential buyers shows quite consistently that market prices are closer to efficient levels in areas with higher educated and generally better off people. These results also support the notion that housing markets may be less efficient than financial markets because of a lack of professional investors operating on the market; the higher educated home buyers would to some extent compensate for this and bring prices closer to efficiency.

Given the strong evidence of an overall lack of efficiency in the market, are there any policy implications to be drawn? This does, of course, depend on the ultimate reason behind our

results. One possibility is that there is a lack of informed and sophisticated buyers on the market to push prices toward efficiency. Policy recommendations under this scenario would include more price transparency and a reform of the current realtor system. Currently in Sweden, there is just one real estate agent involved in the typical home-buying transaction. Though he is given the task to sell the home by the seller and his compensation is based on the sales price, he is also supposed to consider the interests of the buyer. Debate regarding this conflict of interest and whether there should be separate representation of the buyer and seller is currently active in Sweden. Such a reform, however, would only push prices towards efficiency if the real estate agents are themselves 'sophisticated' enough to determine prices that accurately reflect discounted rents. Given that our data come from transactions with realtors involved, this may not be the case; the college education for a realtor is only two years and a parallel debate is ongoing regarding the need to extend this.

An alternative explanation of our findings is that for some at least partially behavioral reason, buyers prefer properties with lower sales prices and higher rents. For instance, the typical buyer may feel uneasy at the prospect of taking on a larger personal mortgage and be willing to pay a premium for the cooperative to hold some of the debt. Thus, if the prices of co-ops reflect such preferences, they may be the outcome of an efficient market process, albeit one based on what most economists would consider irrational preferences. Since it is generally less efficient for the cooperative to hold debt than for the individual members, who typically enjoy more advantageous tax deductions on their interest payments, this hypothesis is also supported by the existence of substantial amounts of debts in cooperatives.

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Table 1. Summary Statistics

| Variable | Mean | Std. Dev. | Within Parish Std. Dev. ⁽³⁾ | Min | Max |
|--|-----------|-----------|---|------------|-----------|
| Price (kronor) | 1,250,685 | 934,297 | 706,249 | 17,500 | 9,450,000 |
| Price per Meter ² | 19,903 | 11,436 | 5,120 | 179 | 86,667 |
| Annual Rent (kronor) | 37,629 | 17,022 | 15,541 | 0 | 199,044 |
| PDV Annual Rent ⁽¹⁾ (kronor) | 1,150,926 | 562,249 | 520,712 | 0 | 4,335,367 |
| PDV Annual Rent ⁽²⁾ (kronor) | 448,351 | 360,062 | 332,252 | -3,046,353 | 3,037,637 |
| Meter ² | 65.78 | 27.19 | 25.39 | 12 | 276 |
| 1 Room | .18 | .39 | .37 | 0 | 1 |
| 2 Rooms | .42 | .49 | .48 | 0 | 1 |
| 3 Rooms | .25 | .43 | .42 | 0 | 1 |
| 4 Rooms | .11 | .31 | .31 | 0 | 1 |
| 5 or More Rooms | .037 | .19 | .19 | 0 | 1 |
| Floor | 2.85 | 1.70 | 1.64 | 1 | 21 |
| Heat | .73 | .44 | .43 | 0 | 1 |
| Stockholm | .51 | .50 | .066 | 0 | 1 |
| Malmo | .22 | .42 | .049 | 0 | 1 |
| Göteborg | .26 | .44 | .058 | 0 | 1 |
| < 10 Years Old | .052 | .22 | .21 | 0 | 1 |
| 10-20 Years Old | .061 | .24 | .23 | 0 | 1 |
| 20-30 Years Old | .049 | .22 | .19 | 0 | 1 |
| 30-40 Years Old | .076 | .27 | .23 | 0 | 1 |
| 40-50 Years Old | .094 | .29 | .26 | 0 | 1 |
| 50-60 Years Old | .29 | .45 | .42 | 0 | 1 |
| > 60 Years Old | .38 | .48 | .38 | 0 | 1 |
| Discount Rate | .048 | .0086 | .0085 | .035 | .070 |

Note –

⁽¹⁾ Discount rate takes 30 percent tax deduction into account.

⁽²⁾ Discount rate takes 30 percent tax deduction into account. A maintenance fee cost of 350 SEK per square meter is subtracted from annual rent.

⁽³⁾ Within standard deviation is the variation within parishes. There are 77 parishes in the sample and 30,479 observations in total.

Table 2. Regressions of Price on Discounted Annual Rent Using Transaction-Level Data

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|------------------------------------|-------------------|------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|
| PDV Annual Rent | 0.38*** (0.07) | -0.36*** (0.08) | -0.75*** (0.10) | -0.51*** (0.04) | -0.51*** (0.04) | -0.51*** (0.03) | -0.52*** (0.03) | -0.45*** (0.02) |
| Meter ² | | 4,362.39 (3,837.32) | 13,467.47*** (3,905.26) | 27,583.36*** (2,462.61) | 27,557.57*** (2,481.60) | 26,967.22*** (2,584.82) | 27,192.93*** (2,574.62) | 26,013.42*** (2,668.19) |
| (Meter ²) ² | | 112.33*** (18.07) | 92.60*** (18.19) | 9.08 (10.99) | 9.27 (10.95) | 22.01* (12.23) | 21.64* (12.22) | 19.79* (11.40) |
| 1 Room | | | | | | 258,792.00*** (82,938.64) | 254,672.13*** (83,065.69) | 224,213.08*** (75,582.27) |
| 2 Room | | | | | | 305,499.74*** (76,186.52) | 301,666.55*** (76,152.56) | 263,668.30*** (68,869.86) |
| 3 Room | | | | | | 277,257.43*** (64,204.89) | 275,030.51*** (64,124.79) | 239,327.18*** (57,222.83) |
| 4 Room | | | | | | 194,080.77*** (46,979.31) | 193,016.63*** (46,924.41) | 174,636.12*** (42,124.92) |
| Floor | | | | | | 29,026.75*** (4,682.00) | 29,144.01*** (4,661.08) | 33,818.87*** (4,514.96) |
| Heat | | | | | | -7,100.84 (8,183.16) | -5,958.86 (8,106.16) | -4,137.19 (6,149.28) |
| 10-20 Years Old | | | | | | -233,931.56*** (54,404.48) | -231,713.27*** (54,445.04) | -133,862.87*** (47,181.86) |
| 20-30 Years Old | | | | | | -238,176.87*** (63,103.69) | -243,902.03*** (63,130.18) | -116,050.87** (47,674.08) |
| 30-40 Years Old | | | | | | -262,909.58*** (57,196.42) | -268,968.13*** (57,090.74) | -139,646.19*** (44,372.72) |
| 40-50 Years Old | | | | | | -183,283.52*** | -191,050.45*** | -83,386.02* |

| | | | | | | | | |
|-----------------|------------------------------|-------------------------------|------------------------------|-------------------------------|-------------------------------|---------------------------------|-----------------------------------|-----------------------------------|
| | | | | | | (54,768.00) | (54,791.71) | (42,673.83) |
| 50-60 Years Old | | | | | | -93,922.78 (57,795.31) | -99,498.78* (57,791.80) | -54,813.21 (42,161.50) |
| >60 Years Old | | | | | | -63,292.81 (62,192.28) | -69,103.18 (62,072.32) | -55,005.96 (50,272.26) |
| Discount Rate | | | | | | | -12945134.34*** (1,500,611.76) | -10957551.33*** (1,338,701.59) |
| Constant | 818,268.44*** (94,029.71) | 808,918.39*** (104,325.77) | 231,229.83** (102,646.16) | 863,050.71*** (126,314.53) | 791,705.19*** (115,272.10) | 1,337,875.76*** (184,023.63) | 1,819,114.68*** (208,306.69) | 563,955.84** (228,557.45) |
| Quarter Dummies | NO | NO | YES | YES | YES | YES | YES | YES |
| Parish Dummies | NO | NO | NO | YES | YES | YES | YES | YES |
| Parish Specific | NO | NO | NO | NO | YES | YES | YES | YES |
| Trends | | | | | | | | |
| Zip Dummies | NO | NO | NO | NO | NO | NO | NO | YES |
| Observations | 30479 | 30479 | 30479 | 30479 | 30479 | 30475 | 30475 | 30475 |
| R-squared | 0.05 | 0.32 | 0.39 | 0.82 | 0.83 | 0.84 | 0.84 | 0.88 |

Note – This table presents the results of regressing sales price on discounted annual rent when the discount factor takes the 30 percent tax deduction into account and assumes an annual amortization rate of zero. Robust standard errors, clustered at the parish-level, are in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. Omitted room category is 5 or more rooms and omitted age category is zero to ten years.

Table 3. Regressions of Price on Discounted Annual Rent Using Quarterly Parish-level Data

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---------------------------|--------------------|----------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| PDV Annual Rent | -0.28*** (0.07) | 0.10 (0.07) | -1.13*** (0.15) | -0.57*** (0.05) | -0.58*** (0.05) | -0.60*** (0.06) | -0.62*** (0.06) |
| <i>Controlling for:</i> | | | | | | | |
| Size | NO | YES | YES | YES | YES | YES | YES |
| Quarter Dummies | NO | NO | YES | YES | YES | YES | YES |
| Parish Dummies | NO | NO | NO | YES | YES | YES | YES |
| Parish Specific Trends | NO | NO | NO | NO | YES | YES | YES |
| Apartment Characteristics | NO | NO | NO | NO | NO | YES | YES |
| Discount Rate | NO | NO | NO | NO | NO | NO | YES |
| Observations | 1005 | 1005 | 1005 | 1005 | 1005 | 1005 | 1005 |
| R-squared | 0.02 | 0.40 | 0.50 | 0.98 | 0.99 | 0.99 | 0.99 |

Note – This table presents the results of regressing average quarterly price in a parish on average discounted annual rent. Controls are listed at the bottom of the table and parallel those included in the transaction-level analysis. Robust standard errors are in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. Observations are weighted by the number of transactions in the same parish and quarter. The discount factor takes the 30 percent tax deduction into account and assumes an amortization rate of zero.

Table 4. Descriptive Statistics of Amortization and Annual Rent Changes in Sample of Göteborg Cooperatives

| | N | Mean | Std. Dev. | Percentile | | | | |
|---|-----|------|--------------|------------|------|------|------|------|
| | | | | 10% | 25% | 50% | 75% | 90% |
| % Change In Rent | 125 | 1.24 | 8.76 | 0.00 | 0.00 | 0.00 | 2.00 | 7.00 |
| Amortization Rate (%) | 125 | 1.70 | 7.82 | 0.00 | 0.00 | 0.53 | 1.67 | 7.27 |
| <i>For Cooperatives with Amortization Rates Between 0 and 5%:</i> | | | | | | | | |
| Amortization Rate (%) | 103 | 0.71 | 0.86 | 0.00 | 0.00 | 0.35 | 1.06 | 2.09 |

Note – Data in this table is based on annual statements for 125 cooperatives in Göteborg. Almost all of the annual statements were from either 2004 or 2005.

Table 5. Regressions of Price on Discounted Rent Using Transaction-Level Data When There is a 1 Percent Amortization Rate

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---------------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| PDV Annual Rent | 0.50*** (0.09) | -0.61*** (0.12) | -1.03*** (0.13) | -0.71*** (0.05) | -0.71*** (0.05) | -0.71*** (0.04) | -0.73*** (0.04) | -0.64*** (0.03) |
| <i>Controlling for:</i> | | | | | | | | |
| Size | NO | YES | YES | YES | YES | YES | YES | YES |
| Quarter Dummies | NO | NO | YES | YES | YES | YES | YES | YES |
| Parish Dummies | NO | NO | NO | YES | YES | YES | YES | YES |
| Parish Specific Trends | NO | NO | NO | NO | YES | YES | YES | YES |
| Apartment Characteristics | NO | NO | NO | NO | NO | YES | YES | YES |
| Discount Rate | NO | NO | NO | NO | NO | NO | YES | YES |
| Zip Dummies | NO | NO | NO | NO | NO | NO | NO | YES |
| Observations | 30479 | 30479 | 30479 | 30479 | 30479 | 30475 | 30475 | 30475 |
| R-squared | 0.05 | 0.33 | 0.40 | 0.83 | 0.83 | 0.84 | 0.84 | 0.88 |

Note – This table presents the results of regressing sales price on discounted annual rent when the discount factor takes the 30 percent tax deduction into account and adjusted for a 1 percent annual amortization rate. Controls are listed at the bottom of the table. Robust standard errors, clustered at the parish-level, are in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Table 6. Heterogeneity Across Parishes

| Parish Number | Coefficient on PDV Annual Rent | Robust Std. Error | 95% Confidence Interval | | Observations | R-squared |
|---------------|--------------------------------|-------------------|-------------------------|--------------|--------------|-------------|
| p1 | -0.78*** | -0.19 | -1.15 | -0.41 | 68 | 0.96 |
| p2 | -0.75*** | -0.17 | -1.08 | -0.42 | 295 | 0.89 |
| p3 | -0.13 | -0.16 | -0.44 | 0.18 | 227 | 0.91 |
| p4 | -0.42*** | -0.11 | -0.64 | -0.20 | 365 | 0.9 |
| p5 | -0.44*** | -0.07 | -0.58 | -0.30 | 984 | 0.9 |
| p6 | -0.77*** | -0.16 | -1.08 | -0.46 | 451 | 0.87 |
| p7 | -0.59*** | -0.15 | -0.88 | -0.30 | 299 | 0.92 |
| p8 | -0.70*** | -0.09 | -0.88 | -0.52 | 931 | 0.91 |
| p9 | -0.91*** | -0.06 | -1.03 | -0.79 | 500 | 0.86 |
| p10 | -0.33*** | -0.11 | -0.55 | -0.11 | 826 | 0.88 |
| p11 | -0.48*** | -0.08 | -0.64 | -0.32 | 832 | 0.87 |
| p12 | -0.62*** | -0.07 | -0.76 | -0.48 | 634 | 0.85 |
| p13 | -0.47*** | -0.11 | -0.69 | -0.25 | 865 | 0.91 |
| p14 | -0.59*** | -0.06 | -0.71 | -0.47 | 1403 | 0.89 |
| p15 | -0.40*** | -0.06 | -0.52 | -0.28 | 583 | 0.77 |
| p16 | -0.72*** | -0.07 | -0.86 | -0.58 | 491 | 0.69 |
| p17 | -0.44*** | -0.10 | -0.64 | -0.24 | 440 | 0.77 |
| p18 | -1.15*** | -0.04 | -1.23 | -1.07 | 900 | 0.78 |
| p19 | -0.83*** | -0.17 | -1.16 | -0.50 | 216 | 0.9 |
| p20 | -0.94*** | -0.14 | -1.21 | -0.67 | 517 | 0.8 |
| p21 | -0.98*** | -0.06 | -1.10 | -0.86 | 174 | 0.91 |
| p22 | -0.65*** | -0.05 | -0.75 | -0.55 | 810 | 0.77 |
| p23 | -1.07*** | -0.08 | -1.23 | -0.91 | 795 | 0.58 |
| p24 | -0.13 | -0.19 | -0.50 | 0.24 | 194 | 0.76 |
| p25 | -0.72*** | -0.06 | -0.84 | -0.60 | 1092 | 0.76 |
| p26 | -0.45*** | -0.16 | -0.76 | -0.14 | 138 | 0.66 |
| p27 | -0.82*** | -0.15 | -1.11 | -0.53 | 258 | 0.76 |
| p28 | 0.15 | -0.11 | -0.07 | 0.37 | 415 | 0.54 |
| p29 | -0.74*** | -0.10 | -0.94 | -0.54 | 397 | 0.75 |
| p30 | -0.18 | -0.23 | -0.63 | 0.27 | 490 | 0.79 |
| p31 | -0.24*** | -0.03 | -0.30 | -0.18 | 690 | 0.76 |
| p32 | -0.57*** | -0.06 | -0.69 | -0.45 | 458 | 0.81 |
| p33 | -0.45*** | -0.07 | -0.59 | -0.31 | 655 | 0.74 |
| p34 | -0.40*** | -0.05 | -0.50 | -0.30 | 1416 | 0.62 |
| p35 | 0.12 | -0.08 | -0.04 | 0.28 | 302 | 0.8 |

| | | | | | | |
|------------|-----------------|--------------|--------------|--------------|------------|-------------|
| p36 | -0.25*** | -0.04 | -0.33 | -0.17 | 638 | 0.75 |
| p37 | -0.40*** | -0.13 | -0.65 | -0.15 | 168 | 0.86 |
| p38 | -0.58*** | -0.10 | -0.78 | -0.38 | 216 | 0.77 |
| p39 | -0.36*** | -0.03 | -0.42 | -0.30 | 208 | 0.71 |
| p41 | -0.68*** | -0.07 | -0.82 | -0.54 | 687 | 0.72 |
| p42 | -0.28*** | -0.04 | -0.36 | -0.20 | 405 | 0.8 |
| p45 | -0.63*** | -0.09 | -0.81 | -0.45 | 511 | 0.79 |
| p46 | -0.40*** | -0.06 | -0.52 | -0.28 | 133 | 0.83 |
| p47 | -0.24*** | -0.07 | -0.38 | -0.10 | 101 | 0.83 |
| p48 | -0.50*** | -0.11 | -0.72 | -0.28 | 358 | 0.76 |
| p49 | -0.87*** | -0.09 | -1.05 | -0.69 | 412 | 0.87 |
| p50 | -0.59*** | -0.10 | -0.79 | -0.39 | 476 | 0.88 |
| p51 | -0.50*** | -0.09 | -0.68 | -0.32 | 488 | 0.8 |
| p52 | -0.42*** | -0.11 | -0.64 | -0.20 | 177 | 0.86 |
| p53 | -0.62*** | -0.08 | -0.78 | -0.46 | 617 | 0.82 |
| p54 | -0.50*** | -0.12 | -0.74 | -0.26 | 204 | 0.79 |
| p55 | -0.55*** | -0.05 | -0.65 | -0.45 | 439 | 0.8 |
| p56 | -0.69*** | -0.12 | -0.93 | -0.45 | 169 | 0.8 |
| p57 | -0.58*** | -0.11 | -0.80 | -0.36 | 318 | 0.84 |
| p58 | -0.11 | -0.07 | -0.25 | 0.03 | 252 | 0.72 |
| p59 | 0.04 | -0.08 | -0.12 | 0.20 | 332 | 0.88 |
| p60 | 0.09 | -0.07 | -0.05 | 0.23 | 87 | 0.88 |
| p61 | -0.06 | -0.09 | -0.24 | 0.12 | 395 | 0.77 |
| p62 | -0.01 | -0.04 | -0.09 | 0.07 | 216 | 0.85 |
| p63 | -0.89** | -0.35 | -1.58 | -0.20 | 52 | 0.84 |
| p64 | -0.07 | -0.14 | -0.34 | 0.20 | 221 | 0.9 |
| p67 | -0.86*** | -0.26 | -1.37 | -0.35 | 110 | 0.8 |
| p69 | -0.42*** | -0.07 | -0.56 | -0.28 | 202 | 0.87 |
| p70 | -0.33*** | -0.05 | -0.43 | -0.23 | 366 | 0.85 |
| p71 | 0.03 | -0.07 | -0.11 | 0.17 | 81 | 0.73 |
| p72 | -0.68*** | -0.05 | -0.78 | -0.58 | 398 | 0.84 |
| p73 | -0.30*** | -0.04 | -0.38 | -0.22 | 229 | 0.76 |
| p74 | 0.10 | -0.23 | -0.35 | 0.55 | 184 | 0.87 |
| p75 | -0.69*** | -0.19 | -1.06 | -0.32 | 115 | 0.91 |
| p76 | 0.01 | -0.09 | -0.17 | 0.19 | 298 | 0.72 |

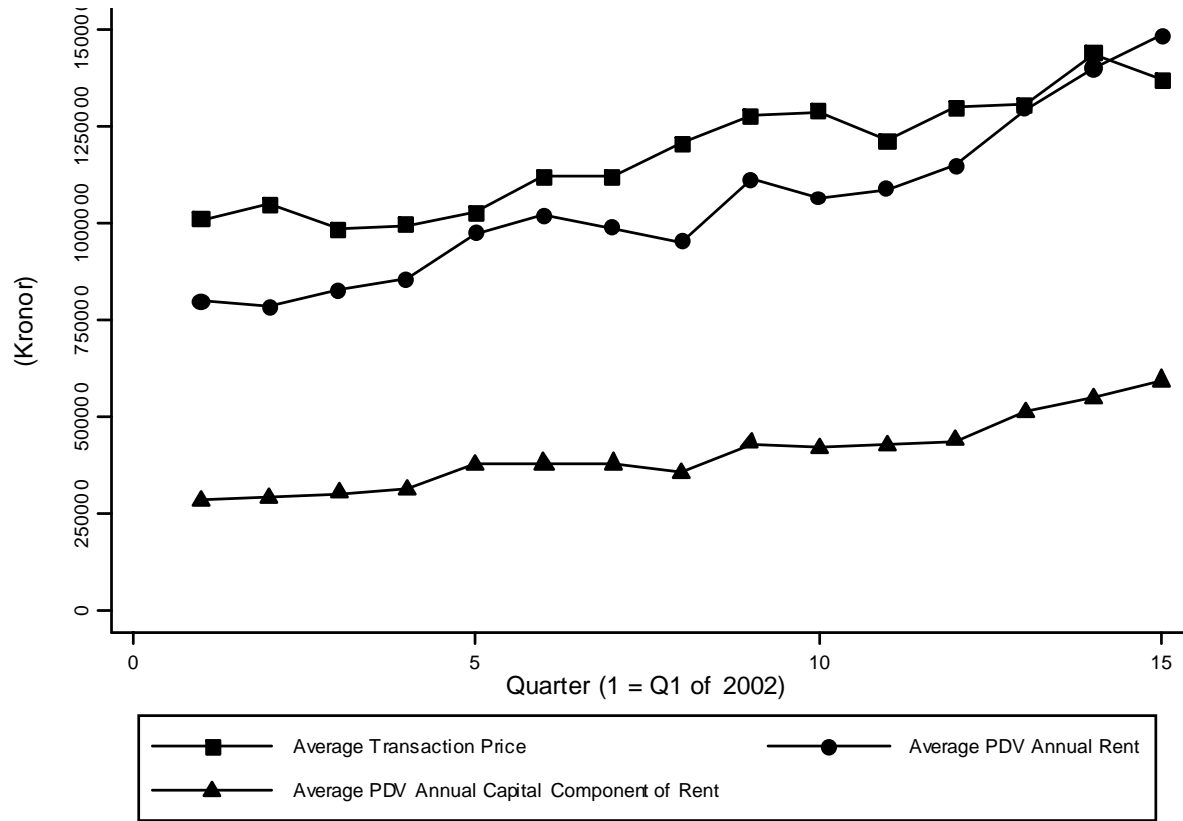
Note – Each row presents the coefficient on the present discounted value of annual rent, taking into account a 30 percent tax deduction and 1 percent amortization rate, when looking at each parish separately. The full set of apartment characteristic controls, quarterly dummies, and interest rate are included in each specification. Parishes with less than 50 observations are omitted. Bolded rows indicate parishes for which the 95 percent confidence interval includes -1.0. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Table 7. Comparison of Average Parish Characteristics for Parishes with More and Less Efficiency

| Outcome Variable | Mean for Most Efficient Parishes (n=35) | Mean for Least Efficient Parishes (n=35) | Difference | T-stat on Difference | Mean for Most Efficient Parishes (n=18) | Mean for Least Efficient Parishes (n=19) | Difference | T-stat on Difference |
|----------------------------------|---|--|------------|----------------------|---|--|------------|----------------------|
| % age < 19 | 0.28 | 0.32 | -0.04 | -2.52 | 0.30 | 0.33 | -0.03 | -1.33 |
| % age 20-24 | 0.06 | 0.05 | 0.00 | 0.88 | 0.05 | 0.05 | -0.01 | -1.18 |
| % age 25-44 | 0.32 | 0.30 | 0.02 | 2.10 | 0.31 | 0.28 | 0.03 | 2.58 |
| % age 45-64 | 0.22 | 0.21 | 0.01 | 1.10 | 0.23 | 0.21 | 0.02 | 1.63 |
| % age >65 | 0.12 | 0.11 | 0.01 | 1.03 | 0.11 | 0.12 | -0.01 | -0.74 |
| % grade school education | 0.10 | 0.18 | -0.08 | -4.74 | 0.10 | 0.20 | -0.10 | -4.16 |
| % high school education | 0.35 | 0.43 | -0.08 | -4.28 | 0.34 | 0.45 | -0.11 | -4.81 |
| % college education | 0.55 | 0.39 | 0.16 | 4.93 | 0.56 | 0.35 | 0.21 | 4.89 |
| average gross labor income | 185,698 | 149,956 | 35,742 | 3.57 | 202,843 | 138,011 | 64,832 | 5.03 |
| average net income | 192,403 | 150,795 | 41,608 | 3.84 | 212,993 | 139,567 | 73,426 | 5.12 |
| average disposable income | 179,439 | 158,903 | 20,536 | 3.10 | 194,519 | 152,633 | 41,886 | 4.81 |
| average net wealth | 631,197 | 406,111 | 225,086 | 2.56 | 784,197 | 373,155 | 411,042 | 3.24 |
| average financial wealth | 260,784 | 171,034 | 89,750 | 2.88 | 298,860 | 164,367 | 134,493 | 3.01 |
| % with income in bottom quartile | 0.26 | 0.32 | -0.06 | -3.63 | 0.25 | 0.34 | -0.09 | -4.75 |
| % with income in middle two | 0.45 | 0.47 | -0.02 | -1.42 | 0.43 | 0.48 | -0.05 | -2.49 |
| % with income in upper quartile | 0.29 | 0.21 | 0.08 | 3.54 | 0.32 | 0.18 | 0.14 | 5.02 |

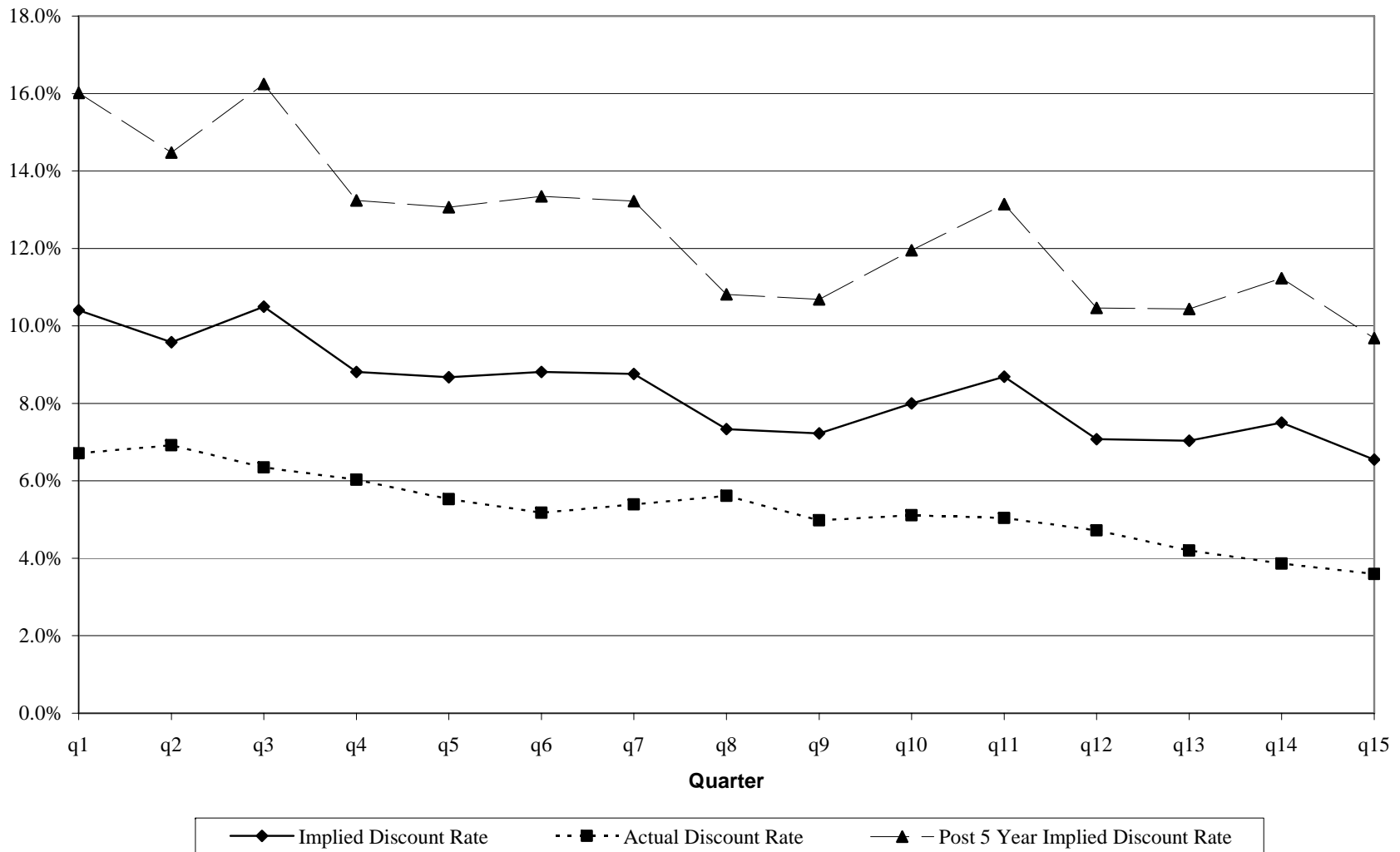
Note – The first group of columns looks at average characteristics for parishes with the estimated rent coefficient above and below the median. The last four columns compare those parishes in the top and bottom quartiles. Rankings are based on coefficient estimates resulting from estimating the transaction-level specification with a 30 percent tax deduction and 1 percent amortization, as well as the full set of controls, separately for each parish. Coefficients are presented in the previous table. Bolded test statistics indicate differences that are significant at the 5 percent level.

Figure 1. Average Quarterly Co-op Transaction Price and Discounted Annual Rent from 2002 to 2005



Note – Discount rate takes into account a 30 percent tax deduction. The capital component of the rent is determined by subtracting out a 350 SEK per square meter maintenance fee cost.

Figure 2. Implied Quarterly Discount Rate versus Actual 5-Year Mortgage Rate.



Note – This figure presents the actual average discount rate for each quarter as well as two estimates of the discount rate necessary to achieve market efficiency. We estimate the implied measures from quarterly regressions that assume market efficiency (i.e. that set $\theta = -1$) and treat the discount rate as the free parameter. The first estimate, labeled ‘Implied Discount Rate’, is the discount rate necessary in *all* future periods to achieve efficiency. The second estimate, labeled ‘Post 5 Year Implied Discount Rate’, is the discount rate necessary in all periods *after* the first five years to achieve efficiency; we assume that the consumer discounts at the current 5-year fixed rate during the initial five years.