A Study of the District of Columbia's Apartment Rental Market from 2000 to 2015:

The Impact of Millennials

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Abstract

The District of Columbia has undergone remarkable commercial development, residential development and demographic changes over the past 20 years. While gentrification may be responsible for many of the city's new, pricey, high-end residential apartment buildings, some of the more recent economic, social and demographic changes that cities are experiencing may be the result of a more inconspicuous process called youthification (Moos 2016). This study tests the hypothesis of youthification in the District of Columbia by looking at the profile of tenants of large apartment buildings built over the past 18 years. The study uses data from CoStar, a commercial real estate industry analytics firm, and 2015 District of Columbia individual income tax data for residents who reside in these respective buildings. We find that while the recent surge of premium apartment buildings in the city is likely evidence of continued gentrification, residents in the city's newest and pricier apartment buildings tended to be new residents to the city, single, younger and had income below the city average, which are typical of youthification.

JEL Classification Codes: R1, R2

I. Introduction

The District of Columbia has undergone remarkable commercial development, residential development and demographic changes over the past 20 years. Some might attribute many of these changes to gentrification (i.e. a large influx of financial capital moving into certain neighborhoods of the city for commercial and residential development primarily to better accommodate wealthier in-migrants). While gentrification may be responsible for many of the city's new, pricey, high-end residential apartment buildings, Markus Moos (2016) argues that some of the economic, social and demographic changes that cities like the District of Columbia are experiencing may be the result of a more inconspicuous process called youthification. He defines youthification as the relative increase in young adults in high-density neighborhoods. He also argues, however, that many of these young, new in-migrants (as individuals) tend not to have incomes commensurate to these typical high housing cost areas.

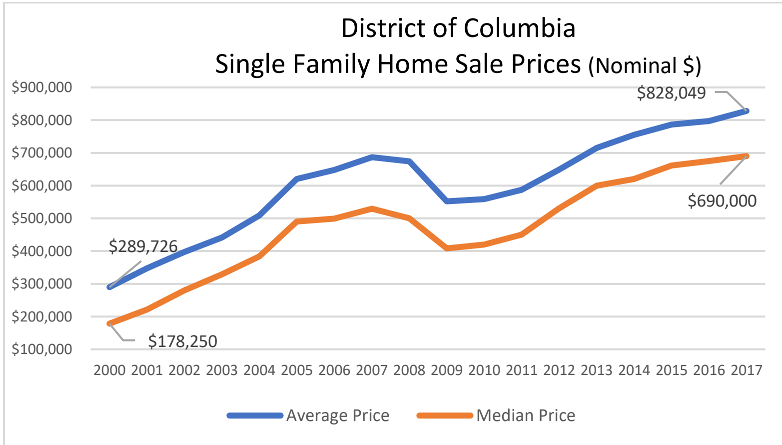
This study tests the hypothesis of youthification in the District of Columbia by looking at the profile of tenants of large apartment buildings built over the past 18 years. We use data from CoStar, a commercial real estate industry analytics firm, for information on apartment buildings (i.e. rents, square footage, vacancy etc.) and 2015 District of Columbia individual income tax data for residents who reside in these respective buildings. This study finds that the recent surge of premium apartment buildings in the city is likely evidence of continued gentrification. However, we also find that residents in the city's newest and pricier apartment buildings tended to be new residents to the city, single, younger and had income below the city average, which are typical of youthification.

II. Homeownership in the District of Columbia

When ranked among the states, the District of Columbia's home ownership rate of 39.8 percent was the lowest in the nation as of the fourth quarter of 2017, according to the U.S. Census Bureau[1] (New York and California were the next lowest at rates of 51.1 and 55.1 percent respectively). One of the many reasons for this is likely the high cost of homes and homeownership in the city. In 2000, half of the homes purchased in the city were priced below $178,250. But, with the median single-family home price nearly quadrupling by 2017, half of the homes purchased in the city were priced above $690,000, (Figure 1). On average, the median sale price for homes in the city increased 8.3 percent per year, while the consumer price index for the Washington area only grew on average by 2.3 percent a year over the same period.

[1] https://www.census.gov/housing/hvs/data/rates.html

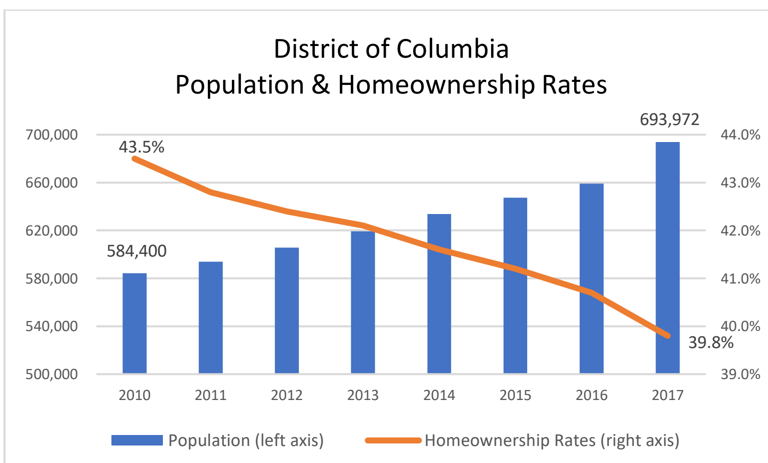
Figure 1



Data source: U.S. Census Bureau

Additionally, the number of single-family home and condo sales have grown at an average annual rate of 4.9 percent between years 2009 and 2017 (MRIS[2]). But since the city has experienced its population increasing by an average of 15,653 people (2.5 percent) every year since 2010, according to the U.S. Census Bureau, one of the key explanatory factors in the city's robust residential development simply appears to be population growth. Home ownership rates and population levels between 2010 and 2017 are shown in Figure 2.

Figure 2



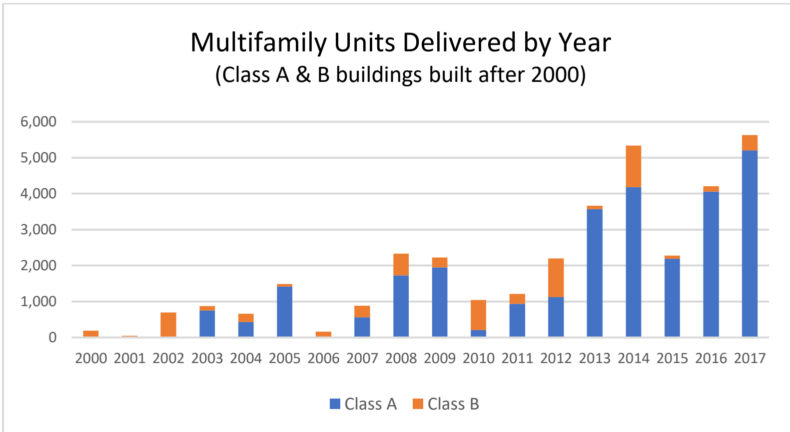
Data source: U.S. Census Bureau, Metropolitan Regional Information Systems, Inc.

[2] Metropolitan Regional Information Systems, Inc.

III. Affordability & Housing in the District of Columbia

For the many residents who choose to avoid a down payment and closing costs of at least tens of thousands of dollars on the purchase of a new home in the city, renting has been the preferred housing option. Between the years 2013 and 2017, the city added over 4,200 multifamily units per year on average, in premium buildings (Class A and Class B) alone, to help accommodate the growing population (Figure 3).

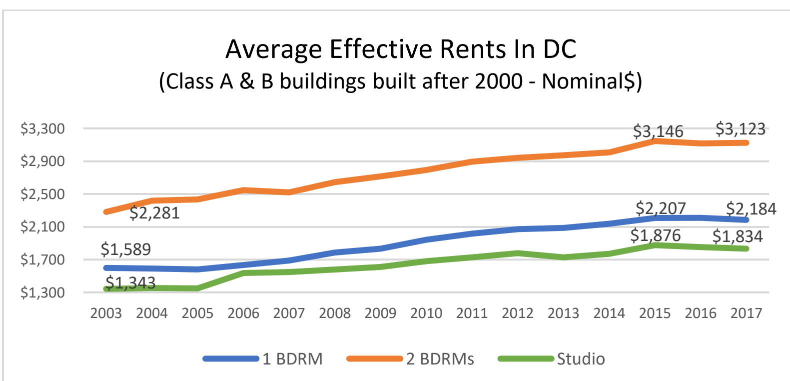
Figure 3



Data source: CoStar

In 2017, the average effective rent for a one-bedroom apartment in the city was $2,184 and $1,834 for a studio apartment (Figure 4). And while these rental rates may be a little unnerving to some, rental rates have generally grown over time in line with the area's consumer price index, unlike the prices for newly purchased homes.

Figure 4



Data source: CoStar

The U.S. Department of Housing and Urban Development defines affordable housing as housing for which the resident occupants are paying no more than 30 percent of their total income for gross housing cost. Alternatively, households paying in the range of 40 to 50 percent of their income towards housing costs are considered moderately to severely housing cost burdened (Anderson, 2017). It is well noted that many renters, particularly in urban and other high-density areas, attempt to offset high rents by engaging in numerous cost-savings measures such as living near their jobs, not owning a car, relying on parental financial support, room-mating[3] etc. Assuming some renters engage in one or more of the above cost-saving behaviors and choose to be severely housing cost burdened, we would generally expect to find no more than a few renters (income earners) in the city's newest apartment buildings with annual incomes of less than $45,024 or $52,968[4], as detailed in Table 1.

Table 1

Scenarios of Estimated Minimum Annual Household Incomes For District of Columbia Rental Units in 2015			
Rent as Share of Gross Monthly Income: 40%			
	Studio	1 Bdrm	2 Bdrm
Annual Household Gross Income	$56,280	$66,210	$94,380
Monthly Household Gross Income	$4,690	$5,518	$7,865
Estimated Monthly Rent	$1,876	$2,207	$3,146
Rent as Share of Gross Monthly Income: 50%			
	Studio	1 Bdrm	2 Bdrm
Annual Household Gross Income	$45,024	$52,968	$75,504
Monthly Household Gross Income	$3,752	$4,414	$6,292
Estimated Monthly Rent	$1,876	$2,207	$3,146

However, when we examine the 2015 District of Columbia income tax records of all the residents that lived in the entire city's 88 Class A and Class B new apartment buildings built after 2000 (see Appendix for the list of buildings included in this study), we find a different story. Table 2 tells us that half of the 10,814 residents who were income tax filers had an annual income of less than $57,428. In 2015, CoStar data indicates that 57 percent of units in these buildings were one-bedroom units, 26 percent were two or more bedrooms and 17 percent were studios. Given that 1) half of the 10,814 individual income earners in this study earned less than $58,000 in annual income; 2) the median household incomes in the city was $70,848[5] in 2015; and 3) the average monthly rent for a one-bedroom apartment remains over $2,100, it appears that room-mating (i.e. households primarily comprised of two or more income earners where at least one person earns modest income) is a predominant feature of the city's apartment rental market. The next section will detail an econometric model that will help us better identify the demographic profiles of residents in these premium buildings.

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[3] In this paper, we refer to room-mating as two or more unmarried income earners living within one housing unit.
[4] As a point of reference, the eligible maximum income amount for the federal Earned Income Tax Credit program in 2015 for a single (married) tax filer was $47,700 ($53,267). The program reduces federal taxes for working adults with low to moderate income.
[5] U.S. Census Bureau

Table 2

Summary Statistics of 2015 Tax Filer Data	
# of Tax Filers	10,814
Income Statistics	**$ Amount**
Mean Income	$75,945
Median Income	$57,428
Minimum Income	-$998,487
Maximum Income	$5,799,739
Standard Deviation	$117,874
Income Tax Filer Type	**Share**
Single Filers (Share)	83.0%
Married Filers (Share)	11.0%
Head of Household Filers (Share)	4.5%
Other Filers (Share)	1.5%
Residents	**Age**
Mean Age	34.2
Median Age	31.5
City Tenure	**Share**
Newest Residents	64.0%
Longer-term Residents	36.1%

Data source: District of Columbia Office of Tax and Revenue

IV. The Data

Using data from CoStar, we identified 88 Class A and Class B large and mid-sized apartment buildings (containing 21,203 total residential units) from across the city that were built after 2000. This data source provided building specific information such as vacancy rate, rents, number of units, types of units, and unit size. This study also uses individual income tax data and identifies all DC tax filers who listed their home address as being in one of the 88 apartment buildings mentioned above in 2015. The income tax data provides information such as each tax filer's adjusted gross income, taxable income liability, capital gains/losses, business income information, age, and filing status.

As shown in Figure 3, there was a tripling in the number of Class A units delivered in 2013 compared to 2012. To better evaluate the data, we bifurcate the building and tax filer data into two cohorts to test if there are significant differences between relatively newer buildings and their residents versus older buildings and their residents. The basic cohort (control group) is comprised of all 2015 tax filers found to be residents in 48 multifamily buildings that delivered between January 2000 and December 2012. These residents will be considered to live in relatively older premium multifamily buildings, which on average contained 240 residential units. The second cohort (treatment group) is comprised of all 2015 tax filers found to be residents in 40 multifamily buildings that delivered between January 2013 and December 2015. These residents will be considered to live in relatively newer premium multifamily buildings, which on average contained 242 residential units.

V. The Model

Simple linear regression models are well-suited for modelling continuous, quantitative variables - e.g. economic growth, consumption, tax collections, personal income, etc. Many economic phenomena of interest, however, concern variables that are not continuous or perhaps not even quantitative. So instead of examining "how much" as in problems with continuous choice variables, binary choice models, on the other hand, examine "which one."[6] This study's investigation of residents' choice of newer versus older apartment buildings falls into such a category. The binary choice model used in this study is such that the dependent variable indicates whether renters chose to reside in a newer premium building ($y = 1$) or an older premium buildings ($y = 0$) in 2015.[7]

The binary choice model is often motivated as a latent variables specification. To explain this concept, suppose that there is an unobserved latent variable y^* that is linearly related to x: $y^* = x_i{}'\beta + u_i$ where u_i is a random disturbance. Then the observed dependent variable is determined by whether y^* exceeds a threshold value: $y_i = \begin{cases} 1 \; if \; y^* > 0 \\ 0 \; if \; y^* \leq 0 \end{cases}$. In this case, the threshold is set to zero, but the choice of a threshold value is irrelevant, so long as a constant term is included in x_i. Then, $Pr(y_i = 1| \; x_i, \beta) = \Pr(y_i^* > 0) = \Pr(x_i'\beta + u_i > 0) = \Pr(u_i > -x_i'\beta)$. If the distribution is symmetric, as in normal and logistic distributions, the above expression can be written as

$Pr(y_i = 1| \; x_i, \beta) = \Pr(u_i < x_i'\beta) = F(x_i'\beta)$ and $Pr(y_i = 0| \; x_i, \beta) = 1 - F(x_i'\beta)$, where F is the cumulative distribution function. Common binary choice models include probit (standard normal error distribution) and logit (logistic error distribution) for the F function. Since we assume that he distribution of the error terms are normally distributed, our binary choice model will be a probit.

The probability model is a regression provided by the following specification (Greene2012):

$$E(y_i|x) = 1 * Pr(y_i = 1|x_i, \beta) + 0 * (1 - Pr(y_i = 1|x_i, \beta)) = F(x_i'\beta) \qquad (1)$$

Given such a specification, the set of parameters β of this model can be estimated using the method of maximum likelihood and indicates the impact of changes in x on the probability. Another key feature of this model is that the coefficients of the parameters of the model are not the **marginal effects** as in the linear regression models. For ease of interpretation, the specific results reported in this paper are the **average partial effects** (APE). The marginal effects can be expressed as

$$\frac{\partial F(x_i'\beta)}{\partial x} = \beta * F'(x_i'\beta) = \beta * f(x_i'\beta) \qquad (2)$$

where f is a density function that corresponds to the cumulative distribution function F.[8] The APE can be interpreted as the percentage change each explanatory variable has on the probability that the observed dependent variable equals 1. It is simply calculated as the sample average of individual marginal effects at each observation i.

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[6] Binary choice models can handle other economic scenarios: what determines labor force participation, or what factors determine whether a person drives to work or takes the train.

[7] We generally regress y on characteristics of renters and other explanatory variables to identify and measure the impacts of these variables on their decisions. A simple linear regression of y on explanatory variables x is not appropriate since, among other things, the residuals of the model are heteroscedastic in a way that the variance of residuals depends on explanatory variables and model parameters. Furthermore, the predicted value of y from a simple linear regression is not restricted to lie between zero and one.

[8] For a probit model, the density function f is simply the density function of a standard normal distribution.

VI. Results

T-Test Results

In one regard, this study is an analysis of two subpopulations: 1) large and mid-sized apartment buildings built between 2000 and 2012 along with their residents and 2) large and mid-sized apartment buildings built between 2013 and 2015 along with their residents. The two-sample t-test is applied to assess whether the difference in the averages of the two groups is truly significant or if it is due instead to random chance. Table 3 shows the newer buildings in 2015 tended to have units that were an average of 88.3 square feet (10.5 percent) smaller and cost 17.5 percent more per square foot. When we turn to descriptive statistics of the renters in these buildings, we find that individual tenants in newer buildings tended to have income that was on average of $9,884 (12.3 percent) less and 1.3 years younger than renters in older buildings. Moreover, the median income for individual tenants in the older buildings was $58,742 while the median income for tenants in the newer buildings was $55,897.

Table 3:

Results of T-Tests			
Variables (in 2015)	Newer Buildings	Older Buildings	Difference
Average Square Feet per Unit	748.6 (18.7379)	836.8 (21.3084)	-88.26*** (28.9452)
Average Effective Rent per Sq. Foot	$3.28 (0.1248)	$2.79 (0.0987)	$0.49*** (0.1571)
Vacancy Rates	6.00 (0.5325)	4.86 (0.4726)	1.1377 (0.7101)
Mean Tenants Income	$70,297.0 (1,193.8)	$80,181.2 (1,768.1)	-$9,884.1*** (2,288.7)
Average Age of Tenants	33.41 (0.1173)	34.76 (0.1341)	-1.3458*** (0.1852)
# of Apartment Buildings	40	48	

Note: Standard errors are shown in parentheses and statistical significance indicated at the 1% (***), 5%(**), and 10%(*) level.

Regression Results

Using a binary choice model where the dependent variable is 1 when tax filers live in a newer building in 2015 and 0 when filers live in older buildings in 2015, we calculate the average partial effects (APE) for all listed explanatory variables. The APE reflects the impact of a one-unit change in explanatory variable x on the probability of renters choosing newer apartment buildings instead of older buildings.

The APE for the DC AGI variable indicates the probability that a resident will choose a newer building instead of an older building for every $1,000 increase in their income. Interestingly, however, the APE for the DC AGI for Model 1 is -0.008 percent and is not statistically. This negative sign implies that as income increases, residents are less likely to choose the newer buildings. The Business Income Binary variable identifies tax filers in this universe of filers as either having or not having business income as a component of their adjusted gross income, which primarily consisted of wage and salary income. The model indicates that residents with business income as part of their adjusted gross income are about 6.7 percent more likely to live in the newer apartment buildings than in the relatively older buildings. However, residents with capital gains income as part of their adjusted gross income are 3.2 percent less likely to live in newer buildings.

In this study, we classify a new resident as someone who existed in the tax data in either 2013, 2014, and/or 2015, but did not exist in 2012 or prior. In this model, new residents are 1.6 percent more likely to reside in newer buildings. But because the estimate is not significant at the 10 percent level, the likelihood for the new residents to live in a newer building is not statistically different from that of the existing residents. The model indicates that for each additional year in age residents are 0.4 percent less likely to reside in new buildings. Stated differently, younger residents are more likely to choose new buildings. Turning to the tax filing status of these residents, the model indicates that head of households (unmarried income earning adults with dependent children) are 17 percent more likely than married filers[9] to live in newer buildings while single filers are 3.8 percent more likely than married filers to do so.[10] While the median income for all tax filers in our dataset was $57,428, the median income for head of household filers was only $34,391. With a median income that is 40 percent less than all other tax filers in this study, the striking presence of these head of household filers in these premium buildings, at least to some extent, may be due to the city's affordable housing efforts.[11] As mentioned earlier in the context of room-mating, head of household filers are also likely engaging in room-mating such that there are two or more income earners in these respective households.

Table 4

Probit Regression Results on Apartment Choice: Average Partial Effects (APE) of Explanatory Variables on Probability of Choosing Newer Apartment Buildings					
Dep: Apartment Choice (1 if newer and 0 if older)	Model 1: Full Sample	Model 2: Income $20k-$250k	Model 3: Income $20k-$250k with Ward Dummies	Model 4: Income $20k-$250k with Ward Dummies New Residents	Model 5: Income $20k-$250k with Ward Dummies Existing Residents
DC AGI ($000's)	-0.008% (0.0001)	0.012% (0.0001)	0.048%*** (0.0001)	0.035%** (0.0002)	0.043%** (0.0002)
Business Income Binary	6.672%*** (0.0141)	5.950%*** (0.0162)	4.912%*** (0.0159)	5.588%*** (0.0210)	3.585% (0.0245)
Capital Gains Binary	-3.173%*** (0.0119)	-3.972%*** (0.0129)	-1.796% (0.0127)	-2.293% (0.0162)	-1.052% (0.0206)
New Resident	1.607% (0.0103)	1.574% (0.0112)	2.813%** (0.0111)	--	--
Age	-0.380%*** (0.0006)	-0.451%*** (0.0007)	-0.540%*** (0.0007)	-0.209%** (0.0010)	-0.869%*** (0.0010)
FS HOH	17.064%*** (0.0266)	17.581%*** (0.0314)	13.197%*** (0.0320)	4.676% (0.0464)	22.682%*** (0.0456)
FS Single	3.846%*** (0.0147)	3.850% (0.0172)	4.858%*** (0.0170)	1.375% (0.0218)	10.002%*** (0.0271)
Ward 1	--	--	-4.369%*** (0.0143)	-5.323%*** (0.0181)	-2.419% (0.0233)
Ward 2	--	--	-17.732%*** (0.0150)	-19.796%*** (0.0185)	-12.734%*** (0.0257)
Ward 3	--	--	-5.315%*	-8.603%**	-0.612%

[9] We group Married filing jointly and mailing filing separately into this Married group.

[10] For our regression models, single filing status is the reference group.

[11] Note: 83 percent of all the tax filers in this analysis were single filers, 11 percent were married filers and 4.5 percent were head of households.

			(0.0277)	(0.0349)	(0.0454)
Ward 4	--	--	12.953%*** (0.0230)	16.998%*** (0.0306)	7.617%** (0.0353)
Ward 5	--	--	23.508%*** (0.0207)	21.816%*** (0.0263)	25.911%*** (0.0335)
Ward 7 & 8	--	--	14.638%*** (0.0330)	22.419%*** (0.0514)	10.254%** (0.0445)
# of observations	10,680	8,761	8,761	5,402	3,359
McFadden R-squared	0.0095	0.0083	0.0409	0.0431	0.0482

Notes: All model specifications include a constant term, and ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 2 gives us an idea of how wide the income distribution is for all these residents. The table tells us that even though the mean income amount is $75,945 and the median income amount is $57,428, one resident has an income as low as approximately a negative $1 million and another an income as high as $5.8 million. To prevent the possibility of extreme income amounts distorting the model's results, we subset the data to residents with incomes between $20,000 and $250,000 and then re-run the regression.[12]

The results for the second regression in Model 2 of Table 4 are like those in Model 1, except that the income variable is now positive but still statistically insignificant. The income variable in the second regression suggests that the level of a resident's income does not make a difference when deciding to live in a newer or older building (the same takeaway for this variable as Model 1) The issue with this result is that conventional wisdom may lead many to believe that since the city's population is growing and that the newer buildings tend to be slightly more expensive than the older buildings, that higher incomes are needed to reside in the newer buildings.

After a more in-depth analysis of the data, a third regression was conducted with controls for the location of each apartment building in the analysis on a ward basis. Model 3 results show that residents are more likely to reside in new buildings when they are in Wards 4, 5, 7 and 8 (generally the eastern half of the city), and residents are less likely to choose to live in new buildings in Wards 1, 2, and 3 (the western half of the city).[13] But more interestingly, when we control for wards, the income variable becomes statistically significant and positive. This means that, now, residents with higher income are more likely to choose newer buildings, as expected. The inclusion of the ward variables is being interpreted to mean that in the first two regressions, which aggregated the income for all residents into one variable, the statistically insignificant and/or negative results were confounding geographical differences of residents across wards. For example, "high income residents" in Wards 5, 7 or 8 may be relatively "low income residents" in Wards 1, 2, and 3. Thus, model 3 is better specified and tells us that there are different income outcomes in different parts of the city.

[12] There were 1,652 filers (15.3 percent) that had an AGI less than $20,000, and they accounted for 1.5 percent of the total income for the dataset. And, there were 299 filers (2.8 percent) that had an AGI greater than $250,000, and they accounted for 15.7 percent of the total income for the dataset.

[13] Ward 6 was the reference ward in this analysis in which 35 percent of the 88 buildings belong (the highest share by ward).

Thus far, we have lumped new residents with existing DC residents in Models 1-3, and their difference is identified by a dummy variable. To better understand the differences in their building choice decisions, we separate the data into two subgroups. Model 4 analyzes building choices of only new residents while Model 5 analyzes such choices for only existing DC residents. Our regression results are quite different for these two groups. Most notably, age and filing status have a much larger impact for existing residents in their building choice. For existing residents, the probability of choosing a new building declines by 0.87 percent as they increase one year of age, while for the new residents the probability of choosing a new building only declines by 0.21 percent for each additional year in age. For existing DC residents, a head of household tax filer(HOH) is 22.7 percent more likely to live in a new building relative to married filers, while this percentage is statistically insignificant for new residents. This may be reasonable given that the waitlist for affordable dwelling units (ADUs) in the city is long and that some applicants wait for more than a year or two to attain a city-government facilitated ADU. Additionally, existing single tax filers are 10. percent more likely to reside in the newer buildings relative to married filers, but again for new single tax filers, there is no statistical difference in their choice of newer versus older buildings.

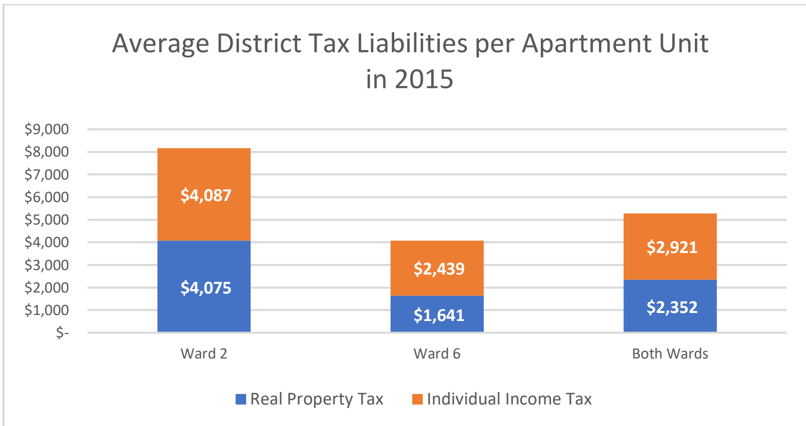
An Interpretation of the Findings

In sum, this study has several findings. *First*, the city's newest apartment units are getting more expensive likely because the rent per unit is remaining relatively constant while the average square footage is getting smaller. *Second*, the city residents with incomes of $250,000 or more tend not to live in the newest apartment units at a greater degree than older buildings, likely because of their preference and ability to afford larger housing units. *Third*, after we limit the regression analysis to residents who earn between $20,000 and $250,000, there is a positive correlation between income levels and the probability to live in the newest units. But, the relationship between the two variables is never more than 0.05 percent for each additional $1,000, suggesting income levels are subsequently not a major factor for residents earning between $20,000 and $250,000 in deciding to live in the newest or not so new rental units. *Fourth*, residents in the city's newest and relatively pricey units were 1.3 years younger than renters in older buildings and had total adjusted gross income that was on average of $9,900 (12.3 percent) less. This is considered statistical evidence of the youthification hypothesis in the city. *Fifth*, this analysis also provides statistical evidence that residents in the newest units are more likely to have business income as part of their total annual adjusted gross income. And this suggests, there is an increased tendency for these residents to supplement their traditional wage and salary income with additional income from entrepreneurial or other self-employment endeavors. *Sixth*, 67 percent of the tenants in the newest buildings were new residents to the city. *Seventh*, single tax filers are more likely to live in newer buildings than married filers. *Lastly* and surprisingly, the analysis shows a relatively strong increase in probability for residents in the newer buildings to be head of household filers, which tend to be even lower income residents. This is possibly due to the city's affordable housing efforts to place low-income households in these new buildings via affordable housing programs. But like other tax filers, these households likely have more than one income earner (i.e. a head of household tax filer and a single filer).

VII. Are the Growing Number of Rental Units (and their Millennial Tenants) Altering the City's Tax Collection Patterns?

When we take a sample of large apartment buildings that were built after 2000 in Wards 2 and 6 (i.e. the commercial core of the city), each of these relatively new apartment units, on average, contributed $2,352 in real property taxes and $2,921 in income taxes to the city's tax collections in 2015 (Figure 5).[14]

Figure 5



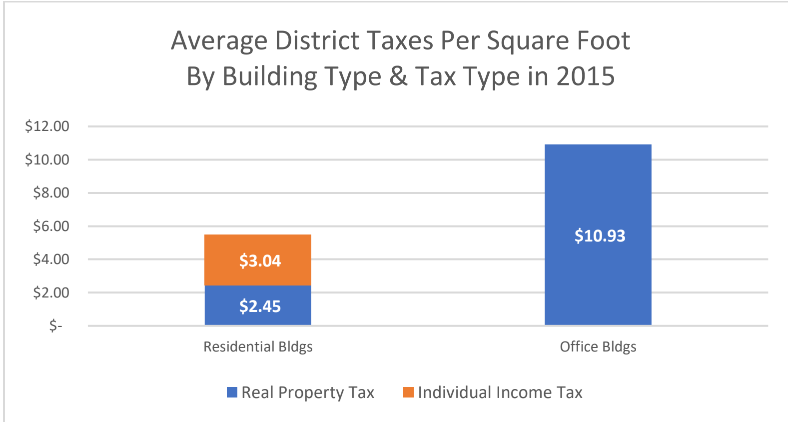
Traditionally, the city's large office buildings (of which there were 547 in 2005 and 614 in 2015) has been responsible for the largest share of city real property taxes. Of the $2.194 billion in real property taxes collected in 2015, $1.032 billion, or 47 percent, was paid by the owners of these commercial office buildings. However, large multi-family buildings (of which there have been over 2,500 between 2005 and 2015) have been responsible for less than five percent of city property taxes. Owners of large multifamily buildings paid $96.2 million, or 4.4 percent of all property taxes in 2015.

Two reasons for the striking dissimilarity in the levels of property taxes paid by these two important two property sectors are economics and tax policy. First, the city's large commercial office buildings remain a favored asset class for global commercial property investors. And second, the commercial property tax rate is more than twice that of residential buildings.

When we examine a sample of large commercial office buildings and large multifamily buildings that were built after 2000 in Wards 2 and 6 (both wards comprise 91 percent of the city's office buildings) on a square footage basis, we find that the property tax liability on commercial office buildings on a square footage basis is more than four times higher that of apartment buildings. And even when we include the total income taxes paid by residents of these apartment buildings, the total income and property taxes only amount to almost half that of property taxes of office buildings, as shown in Figure 6.

[14] With the exception of Ward 3, Wards 2 and 6 had the highest average incomes in the city.

Figure 6



But since the city is changing demographically, one may wonder whether the continuous in-migration of new residents and the over 15,700 market rate units currently under construction will significantly alter these dynamics. When we examine the city's income tax data for Wards 2 and 6, we find that the share of city income tax filers in these two wards accounted for 23 percent of all city income tax filers in 2005 but peaked at 26.5 percent in 2011. We also find that residents in these two wards have always accounted for less than 34 percent of the city's total income. Thus, an increase in the level of property and income taxes stemming from the growth in population and surge in residential property development, the global demand for the city's commercial real estate and the city's property tax policy is likely to preclude the city's ascendant multi-family building sector from rivaling the commercial office building sector in the foreseeable future.

VIII. Conclusions

This study finds that the recent surge of premium apartment buildings in the city is likely evidence of continued gentrification, where gentrification can be generally described as a large influx of financial capital moving into certain neighborhoods primarily to better accommodate wealthier in-migrants. Conventional wisdom assumes that these newer buildings are attracting primarily high-income residents, however we find evidence of youthification instead. In particular, we find that compared to older buildings in this study, the city's newest and pricier apartment buildings built during the recent residential construction surge (2013 and after) tend to attract a higher percentage of new residents to the city, and also attract a higher percentage of single, young residents with income below the city average. It appears that room-mating is a predominant feature of the city's apartment rental market.

We also find that residents in the newest units are more likely to have business income as part of their total annual adjusted gross income. This suggests there is an increased tendency for these residents to supplement their traditional wage and salary income with additional income from entrepreneurial or other self-employment endeavors. Additionally, we find a relatively strong increase in probability for residents in the newer buildings to be head of household filers, which tend to be even lower income residents. This is possibly due to the city's affordable housing efforts to place low-income households in these new buildings via affordable housing programs.

In terms of housing structures, gentrification across the nation prior to the last recession generally took the form of rebuilt or renovated brownstones, industrial lofts, condominium towers, McMansions and simply new and spacious single-family dwellings (Ley, 2003). But many things have changed in the nation's economy since 2008, with youthification being one of them. Consequently, gentrification in terms of housing structures has largely taken the form of smaller rental units in amenity-rich, mixed-use buildings catering to millennials. It seems like the recent surge in new luxury housing units in the District are appealing to a slightly different demographic than the housing units built in the early 2000's. Continued youthification (demand side) and gentrification (supply side) of the city's evolving housing market are likely to have considerable implications on the residential and demographic patterns of the city in the years to come. However, these same dynamics are not expected to alter the city's property and income tax collection patterns in the foreseeable future.

References

Anderson, Courtney L. 2017. You Cannot Afford to Live Here. Fordham Urban Law Journal. Vol.44 No. 2. pp. 247-276.

Greene, William H. 2012. Econometric analysis, Upper Saddle River, N.J: Prentice Hall.

Ley. D. 2003. Artists, Aestheticisation and the Field of Gentrification. Urban Studies. Vol. 40. No.12. pp. 2527-2544.

Moos, Markus. 2016. From Gentrification to Youthification? The Increasing Importance of Young Age in Delineating High-Density Living. Urban Studies. Vol.53, No. 14. pp 2903-2920.

Moos, M and Mendez P. 2015. Suburban Ways of Living and the Geography of Income: How Homeownership, Single-Family Dwellings and Automobile Use Define the Metropolitan Social Space. Urban Studies. Vol.52, No. 10. pp 1864-1882.

Newmark Knight Frank. March 2018. The Apartment Amenities Race: Do More Amenities and Elite Design Lead to Better Performance?

Walter-Joseph. R. 2015. Finding the 'Generationed City': The Form and Structure of Young Adults Settlement Patterns. Master's Thesis, University of Waterloo, Canada. https://uwspace.uwaterloo.ca/handle/10012/9275

Zillow Research, December 2017. "As Rents Rise, More Renters Turn to Doubling Up". https://www.zillow.com/research/rising-rents-more-roommates-17618/

Appendix: Apartment Buildings Used in Analysis

Control Group: Built 2000-2012					Treatment Group: Built 2013-2015			
	Building Address	**Building Name**	**Ward**			**Building Address**	**Building Name**	**Ward**
1	100 Eye St SE	100 Capitol Yards	6		1	100 Florida Ave NE	Elevation at Washington Gateway	5
2	1001 1st St NW	The SeVerna	6		2	1011 1st St SE	Parc Riverside	6
3	1050 New Jersey Ave NW	The Golden Rule Plaza	6		3	1151 4th St SW	Lex at Waterfront Station	6
4	1100 1st St SE	Onyx on First	6		4	1212 4th St SE	Twelve12	6
5	1160 First St NE	Avalon First and M	6		5	1250 9th St NW	The Colonel	2
6	1200 14th St NW	Andover House	2		6	1315 W St NW	14W Apartments	1
7	1255 25th St NW	WestEnd25	2		7	1325-1345 S Capitol St SW	Camden South Capitol	6
8	130 M St NE	Flats 130 at Constitution Square	6		8	1350 R St NW	The Mission	2
9	1301 M St NW	1301 Thomas Circle	2		9	1355 17th St NW	The Drake	2
10	1301 U St NW	The Ellington	1		10	1401 New York Ave NE	The Hecht Warehouse at Ivy City	5
11	1369 Irving St NW	Victory Heights	1		11	1401 S St NW	District	2
12	1375 Kenyon St NW	Park Triangle	1		12	151 Q St NE	The Gale Eckington	5
13	1400 Irving St NW	Highland Park	1		13	1550 11th St NW	HOLM	2
14	1425 P St NW	The Hudson	2		14	1550 7th St NW	Jefferson Marketplace	6
15	1445 P St NW	The Hudson and Desoto	2		15	1717 E Capitol St SE	Bell Capitol Hill	6
16	1499 Massachusetts Ave NW	Post Massachusetts Ave	2		16	1825 7th St NW	7th Flats	1
17	1515 O St NW	The Gatsby	2		17	1916-1934 14th St NW	The Louis	2
18	1600 Maryland Ave NE	Flats at Atlas	5		18	1919 14th St NW	The Harper	1
19	201 Eye St NE	Senate Square	6		19	1924 8th St NW	The Shay	1
20	2221 Eye St NW	Residences on The Avenue	2		20	2 M St NE	2M Street	6
21	2303 14th St NW	View 14	1		21	21 Atlantic St SW	Trinity Plaza	8
22	2323 Pennsylvania Ave SE	The Grays on Pennsylvania	7		22	2112 8th St NW	Atlantic Plumbing	1
23	2400 14th St NW	Capitol View on 14th	1		23	2255 Wisconsin Ave NW	2255 Wisconsin Apartments	3
24	2400 M St NW	2400 M Apartments	2		24	235 Carroll St NW	Takoma Central	4
25	250 K St NE	The Loree Grand at Union Place	6		25	2425 17th St NW	Dorchester West	1
26	2632 Martin Luther King Jr Ave SE	Matthews Memorial Terrace	8		26	2700 Woodley Rd NW	The Woodley	3
27	2701 Calvert St NW	Gables Woodley Park	3		27	300 L St NE	Aria on L	6
28	300 Massachusetts Ave NW	Mass Court Apartments	2		28	3401 Idaho Ave NW	Cathedral Commons	3
29	301 Tingey St SE	Foundry Lofts	6		29	3828 Georgia Ave NW	The Swift at Petworth Metro	4
30	318 Eye St NE	AVA H Street	6		30	3930 Georgia Ave NW	Fahrenheit	4
31	3460 14th St NW	Allegro	1		31	4020 Minnesota Ave NE	Park 7	7
32	3801 Georgia Ave NW	Griffin Apartments at Petworth Metro	4		32	440 K St NW	Lyric 440K Apartments	6
33	400 M St SE	400M Street Apartments Logo	6		33	450 K St NW	450K	6
34	425 L St NW	Meridian at Mt. Vernon Triangle	2		34	5661 3rd St NE	Fort Totten Square	4
35	425 Massachusetts Ave NW	425 Mass Apartments	6		35	60 L St NE	Camden NoMa	6
36	4411 Connecticut Ave NW	Park Connecticut Apartments	3		36	625 Monroe St NE	Monroe Street Market	5
37	443 New York Ave NW	Yale West	6		37	701 2nd St NE	Station House	6
38	444 8th St NW	The Lexington at Market Square	2		38	77 H St NW	77 H	6
39	450 Massachusetts Ave NW	Meridian at Gallery Place	2		39	800 P St NW	City Market at O	6
40	460 L St NW	Gables City Vista	6		40	875 10th St NW	The Apartments at CityCenter	2
41	5210 3rd St NE	Aventine Fort Totten	5					
42	600 Barnes St NE	Victory Square Senior Apartments	7					
43	70 Eye St SE	70 Capitol Yards	6					
44	7035 Blair Rd NW	Gables Takoma Park	4					
45	750 3rd St NW	Ashton Judiciary Square	2					
46	770 5th St NW	Avalon at Gallery Place	2					
47	850 Quincy St NW	Park Place at Petworth	4					
48	900 5th St SE	Arthur Capper Senior I	6					

Data source: CoStar