

# Housing Tenure and Housing Demand in Colombia

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### **ABSTRACT**

Using the 2003 and 2008 Quality of Life Surveys, we identify the factors that affect housing tenure decisions in Colombia and explore the determinants of the demand for rentals and purchases. Variables affecting the choice between buying and renting include civil status, education, age of the household head, size of the household and whether the household resides in an urban area. Households with higher income are more likely to purchase than to rent and the choice of formal housing is positively associated to wealth. Interestingly, households eligible for social housing subsidies are more likely to purchase than to rent and those working in the informal sector are more likely to purchase informal dwellings. Demand is quite responsive to price changes as well as to changes in the price of rental (its closest substitute). The elasticity to permanent income for both buying and renting is similar to that observed in other developing countries, and is higher for those working in the informal sector. This suggests that subsidies and other interventions aimed at fostering demand should not exclude those holding informal sector jobs. Demand is highly responsive to positive shocks to income, a fact probably associated with credit constraints being binding. Subsidies have a large positive impact on demand. Likewise, access to mortgage credit is an important determinant of demand. Finally, savings have a positive effect on demand in 2008, not in 2003. A plausible explanation is that a policy intervention that began in 2000 –i.e, a tax exemption for households that established savings accounts destined for housing purchases— only had an effect in the upper part of the business cycle. In both cases (i.e. subsidies and credit) the positive effect on demand is entirely explained by demand for social housing.

JEL Classification: G21, O54, R21, R28, R38, R58

Key Words: Housing demand, tenure choices, housing market policies, Colombia

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## **INTRODUCTION**

Housing is an important sector in any economy and a thorough understanding of the determinants of housing demand is essential. An analysis of the determinants of formal and informal housing in developing countries is a useful instrument for the design of policy interventions geared at promoting welfare through the formalization of the housing market. In this paper this analysis is undertaken from two different perspectives: (1) the election of tenancy option (i.e. formal or informal purchases vs. rentals); and (2) the determinants of housing demand. A key element in our analysis is the potential role played by access to financing and by subsidies for construction and for acquisition. The paper is divided into four sections. The first section presents a brief review of the literature related to housing demand. The second describes the evolution of the housing sector in Colombia and makes a succinct inventory of the salient public policy decisions with regard to housing, focusing on social housing. The third section presents the econometric estimations related to housing tenure and housing demand. The fourth section concludes and provides some policy recommendations.

### **1 LITERATURE REVIEW**

There is a vast literature regarding the determinants of housing tenure choice in developed countries. In general, these studies do not analyze the informal dimension of housing, as in these countries the choice is to a great extent limited to buying or renting formal dwellings. In developing countries there are, in addition to formal alternatives, different informal ones: (i) there is the option of buying property in an illegal housing project, in which a promoter sells dwellings located in zones in which housing developments are not allowed; (ii) there are owner-build houses in a land that has been illegally taken over and in which development norms are not followed (Cocatto, 1996 and Dowall, 2006). In many instances these arrangements are explained by people being displaced from rural areas and by local governments's inability to promote and control the supply of urban land (Dowall, 2006). Unsurprisingly, the main finding of studies on housing demand in developing countries is that demand for informal housing is more prevalent among low-income households.<sup>2</sup>

Several studies on the determinants of housing demand are based on the framework advanced by Rosen (1979), Gillingham & Hageman (1983) and Goodman (1988). In the case

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<sup>2</sup> See Jacobs and Savedoff (1999) and McCann and Koizumi (2006) for the case of Panama and Morais and Cruz (2007) for the case of Brazil.

of the decision to purchase, these studies highlight the need to analyze the decision to buy or lease, jointly with the decision on how much to spend, in case the purchase is the chosen option<sup>3</sup>. The joint estimation allows for the identification of the price-elasticity of demand. Goodman's (1988) methodological proposal has been applied by Cadena *et al.* (2010) to the housing market in Guayaquil and by Fontela & Gonzalez (2009) to the case of Mexico.

Colombia's housing sector has been the focus of several studies, most focusing on housing finance. Murcia (2007) finds that the probability of having a mortgage is higher for households in urban areas, for those receiving a government subsidy and for those in the highest quintile of the income distribution. Rocha *et al.* (2006) analyze barriers to accessing credit by poor households, Cuéllar (2006) focuses on how regulatory aspects have affected financing of low-income housing, while Silva (2007) assesses the impact of public policy aimed at enhancing credit for low-income housing. There is only scant literature identifying the determinants of housing demand and supply. Clavijo *et al.* (2005) and Arbeláez (2006) use macro-level data. The first paper undertakes an econometric analysis of the short-term determinants of supply and demand for 1991-2004 and reports evidence that housing demand is elastic to the price of new houses, to the real rate of interest and to income. Along the same lines, Arbeláez (2006) estimates supply and demand for 1997-2003 and finds that the amount of credit, the real rate of interest, labor income and unemployment are all determinants of housing demand. Using micro level data, Ingram (1984) finds that demand in Bogota and Cali is positively related to household size. For renters he finds an income elasticity of 0.47 and a price elasticity of -0.48 for Cali and of 0.72 and -0.28 for Bogota. For owners he reports higher income elasticities (0.76 in Cali and 0.78 in Bogotá), and a lower price elasticity for Bogota. Assadi and Ondrich (1993) use a simultaneous model of housing demand, location and labor supply for the same cities. They find that the income elasticity of demand is 0.56.

## **2 THE HOUSING SECTOR IN COLOMBIA**

This section is divided into two parts. In the first one we characterize Colombia's housing market; we describe the evolution of construction activity, real estate prices and social housing finance. In the second we focus on regulatory issues including norms governing the rental market and on public policy aimed at promoting demand, particularly among the poor.

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<sup>3</sup> This framework is based on the notion that if one only takes into account the amount of expenditure undertaken, without due consideration to the choice between housing alternatives, OLS estimates will be biased if, indeed, the two decisions are undertaken simultaneously.

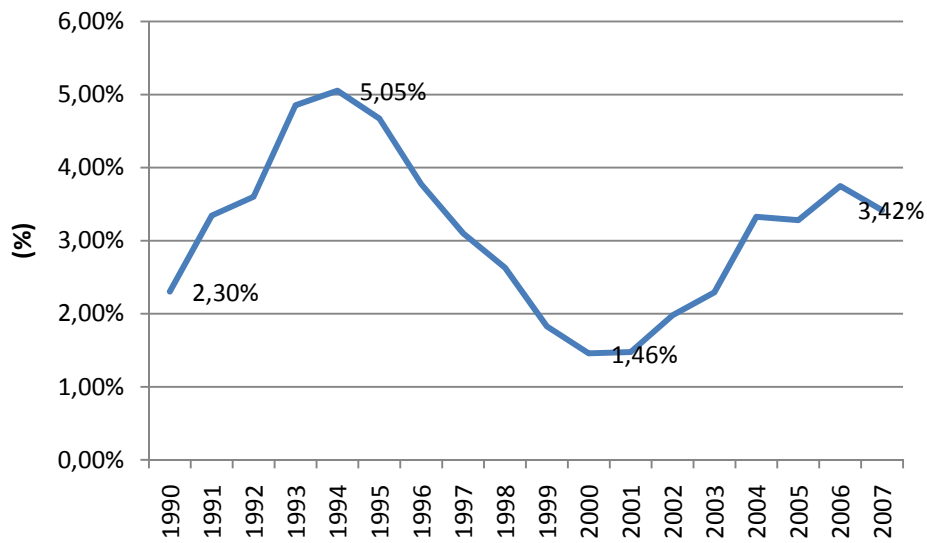
## 2.1 Characterization of Colombia's housing market

Housing activity, particularly social housing, has gone through a slump in the last two decades. This helps explain an important qualitative and quantitative deficit. The quantitative deficit is in the order of 1.3 million units, placing ownership indicators generally below those of other countries. This deficit is related both to supply considerations associated with the high cost of land and with demand elements, including lack of credit, a particularly prevalent problem in the case of social housing. All indicators of construction activity show a sharp decline starting in 1995. After bottoming out in 2000, activity has recovered, but by 2008 it had not reached the levels observed in the early 1990s. As a percentage of GDP, housing and other construction<sup>4</sup> went from 5% in 1994 to 3.4% in 2007 (Graph 1). Sectoral GDP annual growth peaked at 44% in 1993; it became negative in 1995 (-4.5%) and bottomed out at -32.2% in 1999. Growth became positive in 2000, and reached 25% in 2007. Construction licenses are a relevant indicator of (intended) activity. With regard to total housing, licenses peaked at 12.3 million square meters in 1994. They declined to 5.5 million in 1999 and then recovered, reaching 13.9 million in 2007. With regard to social housing (VIS for its Spanish acronym), licenses reached a maximum of 3.1 million square meters in 2002. They declined to 2 million in 2004, and recovered to 2.9 million in 2007 (Graph 2).

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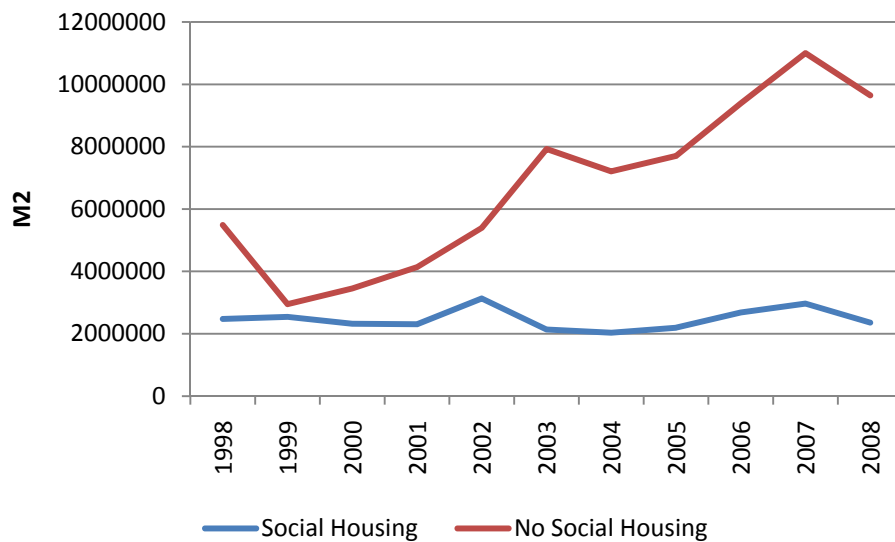
<sup>4</sup> Includes housing construction and other types of buildings (i.e. malls and commercial facilities) and excludes public infrastructure.

**Graph 1: Housing Sector Share in GDP (1990-2007)<sup>5</sup>**



Source: DANE

**Graph 2: New Construction Licenses (1998-2008)**



Source: DANE

The relationship between standards of living and dwelling conditions is examined via the quantitative and qualitative deficits. The former shows how many units are needed to achieve a balance between the number of households and the number of housing units. The latter is defined as the proportion of primary housing units with three addressable deficiencies: over-

<sup>5</sup> Includes urban & rural residential, non-residential and repair of buildings and maintenance. Source: Dane

crowdedness<sup>6</sup>, inadequate utilities and building deficiencies. In 2005 the quantitative deficit was 12.4% -- i.e. 1.3 million additional units were needed in order for every household to be sole user of a house (Table 1). This percentage has fallen by a third since 1993. Likewise, the qualitative deficit has declined, from 37% in 1993 to 24% in 2005. Clearly, the housing deficit has more to do with the quality of housing than with household's not owning a dwelling. Many households live in their own houses, but in conditions of over-crowdedness. According to the 2005 Census, some 80% of dwellings have basic services (electricity, water, sewerage), while access to services with substitutes is lower (Table 2).

**Table 1: Housing Deficit**

	1993		2005	
	# of households	%	# of households	%
Total Households	7,159,825.00	100%	10,570,899.00	100%
Total Housing Deficit	3,841,300.00	53.7%	3,828,055.41	36.2%
Quantitative Deficit	1,217,056.00	17.0%	1,307,757.24	12.4%
Qualitative Deficit	2,624,244.00	36.7%	2,520,298.16	23.8%

Source: DANE Census

**Table 2: Access to Public Services**

	Access	No Access
Electricity	93.61%	6.39%
Sewer system	73.06%	26.94%
Water	83.41%	16.59%
Natural Gas	40.32%	59.51%
Telephone	53.40%	46.05%

Source: DANE, Censo 2005

With regard to the percentage of the urban population living in informal settlements in Latin America, according to UN-HABITAD in 2005 Chile (9%), Costa Rica (10.9%), Paraguay (17.6%) and Colombia (17.9%) were the countries that fared better, with Bolivia (50.4%), Honduras (34.9%) and Brazil (28.9%) in the other extreme. On the other hand, in 2007 only half of Colombian households owned their house, a lower percentage than in many countries with a lower per capita GDP (Table 3). Interestingly, in Europe home-ownership is much higher in peripheral countries than in wealthier France, Sweden and the Netherlands.

<sup>6</sup> Over-crowdedness is defined as five persons living in one room.

**Table 3: Ownership and GDP (2007)**

Country	Owners/Households (%)	GDP per capita (USD, PPP)
Bolivia	66.4	4,091
Brazil	73.8	9,854
Colombia	50.3	7,983
Costa Rica	71.7	10,451
Honduras	72.0	4,109
Panama	79.1	10,372
Paraguay	79.7	4,518
Uruguay	65.9	11,529
Venezuela	81.4	12,201
United States*	68.0	46,674
United Kingdom*	70.0	35,512
Spain*	83.0	30,186

\* Clavijo *et al* (2005) and ECLAC.

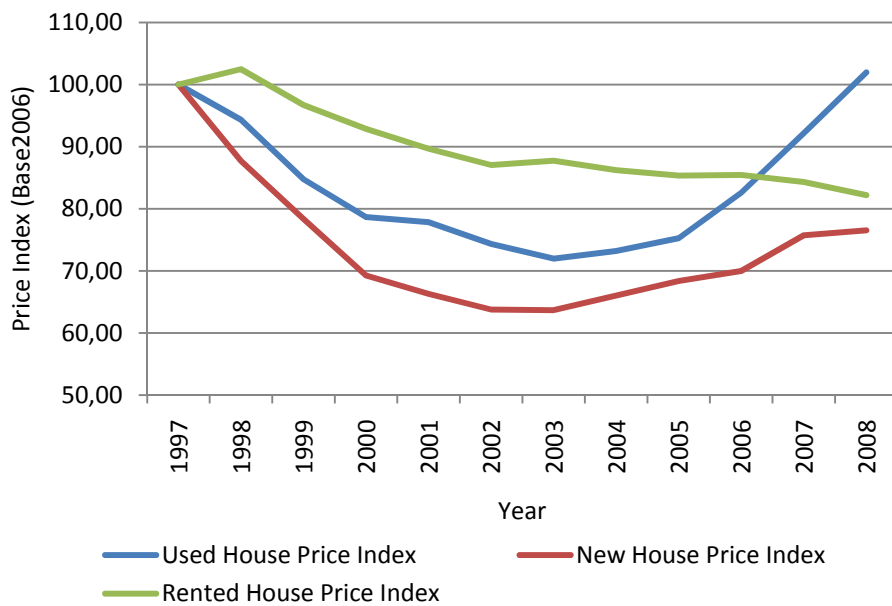
We now review some facts that may explain the housing deficit. Graph 3 shows the real price index for new and old houses and for rentals. Prices of new houses peaked in 1997; they declined 63% from 1997 to 2003 and have increased 87% since. In 2008 they were back to their 1999 level, 76% lower than in 1997. Using the repeated sales methodology, the central bank constructs a used houses price index with assessments by financial institutions at the time of a loan approval. This index peaked in 1995; it consistently declined until 2003 and has recovered since. In 2009 it reached its 1995 level. Interestingly, rental prices evolved similarly to prices in the downturn, but have not witnessed a recovery in the last five years<sup>7</sup>.

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<sup>7</sup> With regard to land prices, data is only available for a shorter period and is deemed to be of lesser quality. Between 2003 and 2008 prices have been somewhat volatile, in all increasing by around 1.5% in real terms.



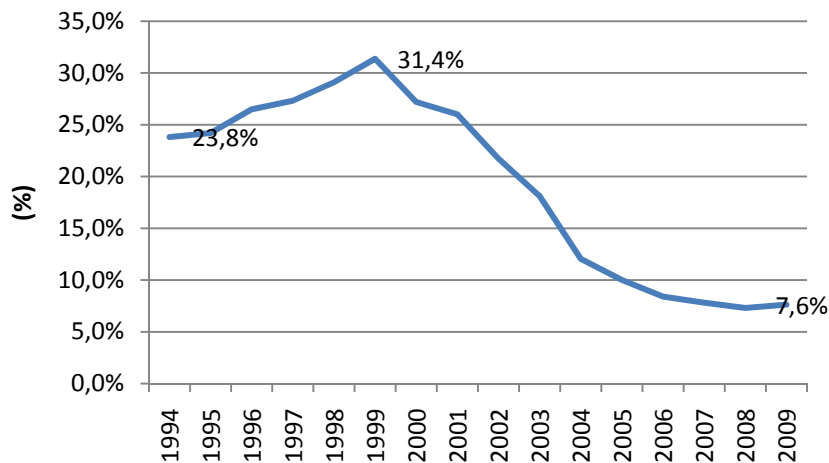
**Graph 3: Real Price Indexes for New and Old Houses and for Rentals**



Source: DANE

With regard to credit, the ratio of mortgage loans to total financial sector loans went from 23.8% in 1994 to over 31% in 2000; it then plummeted and stood at 7.6% in 2009 (Graph 4).

**Graph 4: Mortgage Loans/Total Loans**

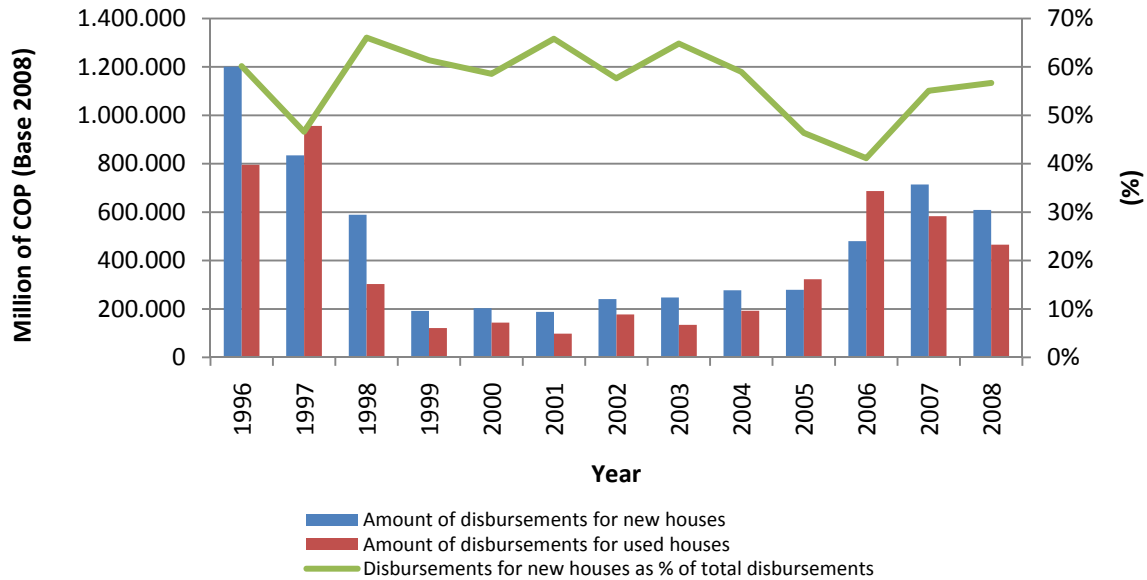


Source: Financial Superintendency

Disbursements by financial institutions can be divided between those financing purchases of new houses and those financing purchases of used houses (Graph 5). Disbursements for new houses went from 60% of total disbursements in 1996 to 41% in 2006, with the total amount of disbursements declining significantly. The recent recovery in disbursements has been led

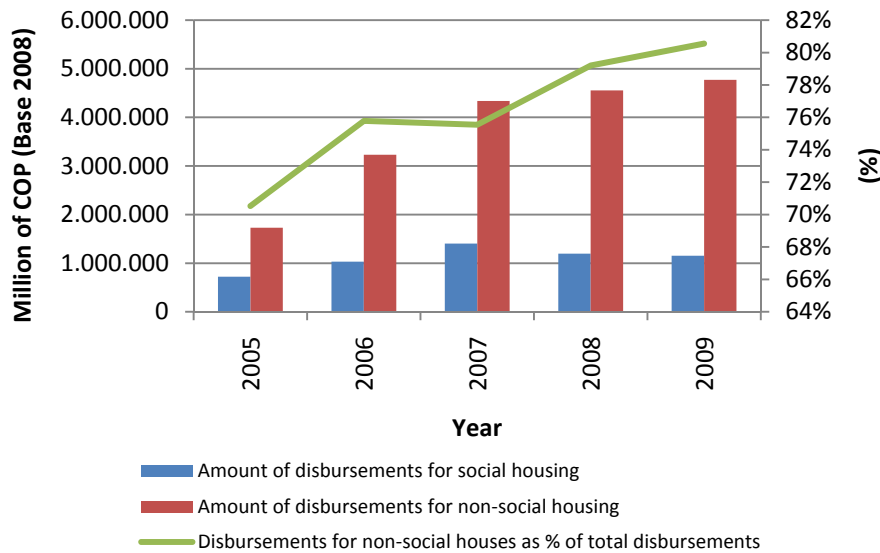
mostly by loans for purchases of new houses. Disbursements for social housing averaged 23% of total disbursements between 2005 and 2009 (Graph 6).

**Graph 5: Disbursement for Purchase of New and Used Houses**



Source: Financial Superintendency

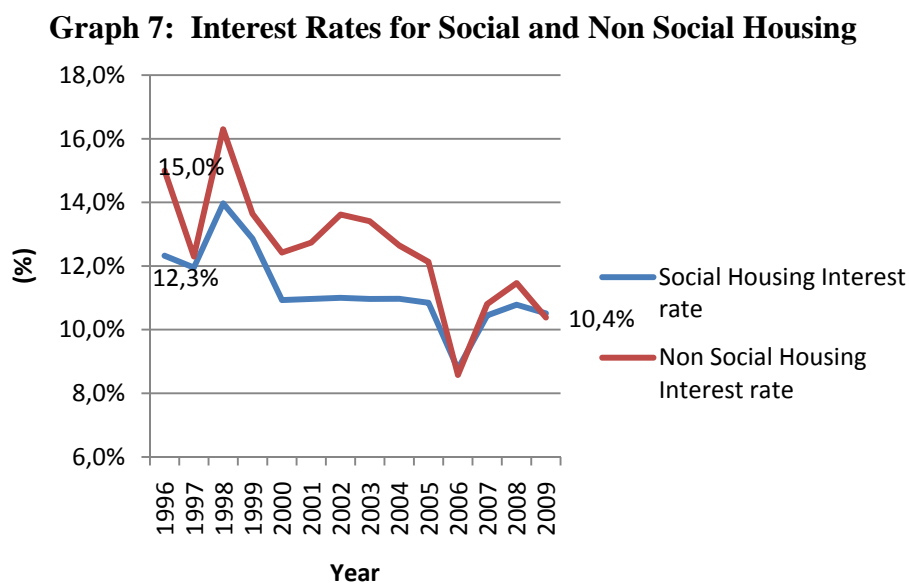
**Graph 6: Disbursement for Social and Non Social Housing**



Source: Financial Superintendency

With respect to mortgage interest rates, these are expressed in terms of a unit of account indexed to inflation (UVR for its acronym in Spanish). Graph 7 shows interest rates (on top of the annual change in UVR) for social and non-social housing. Both rates peaked in 1997,

declined almost continuously until 2006 and have increased since. Interestingly, rates on non-social housing go through periods in which they are roughly equal to rates on social housing<sup>8</sup>.



Source: Financial Superintendency

## 2.2 Housing Policy and Institutions

### 2.2.1 Rental Housing

**Law 820 of 2003.** The government was concerned with the results in the 2001 National Households Survey, according to which some 3 million families did not own any housing nor had enough resources to purchase one, despite the loans and subsidies granted by the government. This implied a failure to comply with Art. 51 of the Constitution, according to which all citizens must have access to decent housing. A solution that emerged was to eliminate the distortions in the market for urban rentals. The rule in force at the time gave little incentive to build housing for rental purposes, was not equitable between the parties and granted no warranties with respect to the reinstatement of the property to its original owners at the end of the contract (Castaño 2004). The main reforms introduced in 2003 were:

<sup>8</sup> According to Law 546 of 1999, the interest rate for mortgage loans for social housing is capped at 11%, for non-social housing at 13.92%.

- The establishment of solidarity in the leasing contract, so that obligations may be demanded by or met by all or any of the landlords or tenants. This implies that the landlord may sue the tenant in order to make him responsible for the rental fees and the reinstatement of the property, without the need of summoning both parties in a judicial process (Cuellar, 2006).
- Elimination of solidarity from the lease contract and reinstatement of the property whenever the tenant fails to comply with obligations derived from utility contracts, provided that: (i) the landlord has previously announced the existence of the lease contract with the utilities company, and (ii) the tenant has requested the landlord the underwriting of insurance against the possible nonpayment of public services.
- The increase in rental fees would equal 100% of registered inflation in the previous year, up from the 90% increase established in 1985.
- The grounds for termination of the contract became more flexible.
- Law 820 granted fiscal incentives to social housing renters and authorized the creation of Real Estate Investment Funds in order to develop the real estate business associated with social housing rentals. As of yet, no fund has been established.

It has been found that renters have taken advantage of loopholes in the law and have stopped paying rental & administration fees and public services. The latter may be a consequence of the troublesome and tedious legal process that landlords must endure. A study by Fedelonjas (2006) found that there continues to be delays in the reinstatement process, especially on the police inspector's part, since a judicial order is required and this may take months or years.

### **2.2.2 Policy Instruments to Promote Housing Demand**

**Direct Subsidies.** Public housing subsidies were created by Law 3 of 1991. Before implementing such policy, a large part of public resources destined towards the construction of housing for low income population were being wasted or were not making it to their final destination (Jaramillo, 2009). The whole idea behind granting demand subsidies directly to the users is that (i) this would create competition amongst promoters, thus reducing prices; and (ii) someone purchasing a house can now choose the best option according to his (her) needs. Direct subsidies for the purchase of housing have been managed by four institutions: 1) Fonvivienda (formerly Inurbe); 2) Family Welfare Agencies (FWA); 3) the Military

Housing Promotion Agency (MHPA) and; 4) the Public Agricultural Bank. The subsidies granted by these institutions are financed by the National Budget and by payroll taxes.

During 1991-2009, Fonvivienda and the FWA handed out close to 72% of all subsidies. Targeting the poorest households has been based on two conditions: i) applications for the subsidy are restricted to households earning less than 4 monthly minimum legal wages (mlw) or households ranked in the lowest living conditions; and ii) subsidies are assigned by a scoring methodology that ranks applicant households according to their saving efforts and socio-economic characteristics. Initially, the maximum awarded by Inurbe was set at 25 mlw for housing valued at less than 70 mlw, while the maximum value of the subsidy granted by the FWA was inversely related to household income. In regard to Fonvivienda, Table 4 shows that between 1997 and 2009 the maximum value of the subsidy decreased for all types housing, especially for those valued above 70 mlw. Since 2004 FWA's began applying Fonvivienda's methodology, the maximum value of the subsidy depending on the value of the house. In 2007 it was stipulated that the maximum value awarded by Fonvivienda would depend on the SISBEN score<sup>9</sup>, and in the case of the FWA the maximum value would depend on household income. Moreover, in 2007 it was established that public entities may only grant subsidies for the acquisition of housing whose value is less than 70 mlw.<sup>10</sup>

**Table 4: Fonvivienda and Family Welfare Agencies (FWA)  
Maximum Value of the Subsidy (in monthly minimum wages)**

Housing Prices		30-50	50-70	70-100	100-135
Decree 824/99		25	25	25	20
Decree 2620/00		23	16	16	10
Decree 1585/01		25	25	20	20
Decree 2488/02		23	16	16	10
Decree 975/04	Fonvivienda	21	14	7	1
	FWA	17	12	7	1
Dec.1526 & 4429/05 <sup>/1</sup>		21	14	7	1

<sup>/1</sup> Decree 4429 of 2005 increased FWA's maximum value of the subsidy to 10 mw for housing between 70 and 100 mw

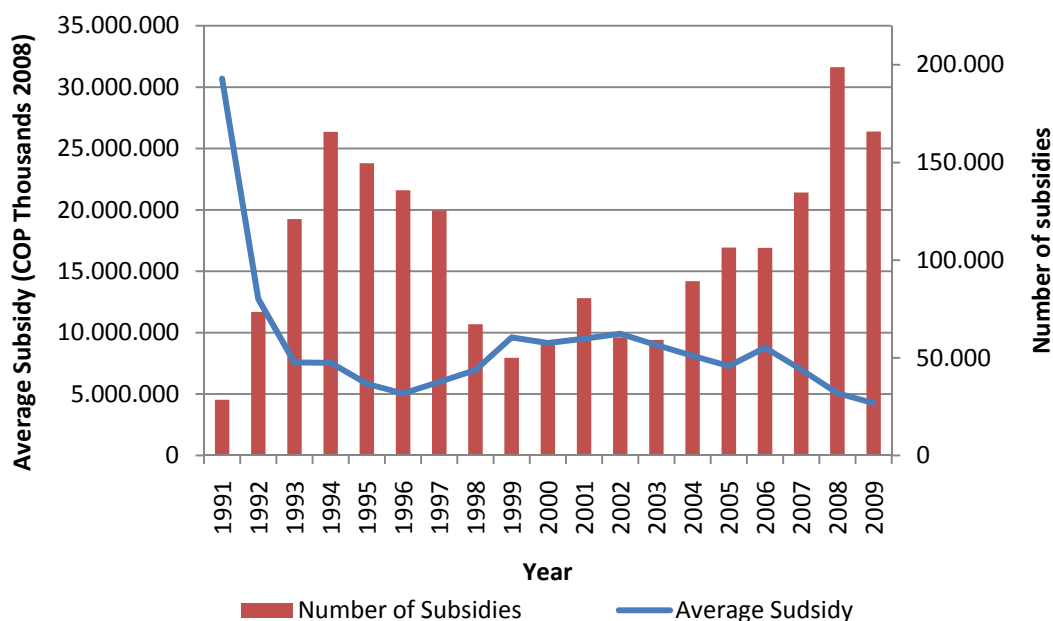
Source: Ministry of Environment, Housing and Regional Development (MAVDT), Arbeláez *et al.* (2010)

<sup>9</sup> SISBEN is an indicator of households' well-being. It serves as an instrument to target social programs. The index is a function of a set of variables related to the consumption of durable goods, human capital endowment and income. The Social Housing Subsidy is targeted to households ranked in the two lowest SISBEN levels.

<sup>10</sup> This does not apply to Family Welfare Agencies as they are governed by private law.

According to the Ministry of Environment & Housing, during 1991-2009 Fonvivienda, the FWA and the Public Agricultural Bank granted subsidies equivalent to 0.2% of GDP; 104.000 households per year received benefits<sup>11</sup>. The average value of the subsidy peaked in 1991, declined significantly in 1992, and has remained relatively stable since (Graph 8).

**Graph 8: Evolution of Subsidies**



Source: Ministry of Environment, Housing and Regional Development; Arbeláez *et al.* (2010)

**Programmed Saving Accounts.** In 1991, when the program of subsidies for social housing was created, it was decided that as part of the criteria for being nominated as a possible beneficiary, households had to prove they had savings capacity. During 1991 and 1992 this criterion acted as an important entry barrier; in 1993 it was abolished for future applicants. Nonetheless, in 2000 the government once again stipulated that in order to apply for a subsidy, households must meet some requirements regarding savings. Programmed saving accounts were created as a means for applying households to gather, through periodic savings, enough resources in order to make an initial down-payment. The amount that must be saved during the contract period must be at least 20% of the value of the property. Via programmed saving accounts households are entitled to tax exemptions.

<sup>11</sup> In Colombia there are around 9 million households, 50% of which are considered to be poor.

**Saving Accounts for Housing Purchase** were created in 2000 as a mechanism similar to the subsidies granted for the acquisition of social housing, but targeted to middle and high income households. Through these accounts, households receive tax exemptions; they may transfer the amount of the tax due as a contribution to the down-payment or to the monthly mortgage fee. The maximum monthly savings a beneficiary may have is 30% of his (her) paycheck. This deposit may only be used in order to purchase housing (new or used).

**Interest rate subsidies.** Since April 2009 this subsidy is channeled through banks, in charge of processing credit applications. The government pays up to 5 percentage points of the interest rate if the value of the house is less than \$70 million<sup>12</sup>, up to 4 p.p. if the price range is within \$70-\$120 million, and up to 3 p.p. if the price range is within \$120-170 million. The benefits awarded will only last for the first 7 years of the loan. These measures help reduce the monthly fee by up to a 30%. This benefit is expected to have a higher impact on middle income households as low income households have access to alternative programs.

### **3 HOUSING TENURE AND HOUSING DEMAND IN COLOMBIA**

#### **3.1 The data**

We use the National Quality of Life Survey (QLS) conducted by the National Department of Statistics (DANE). It was conducted in 2003 and 2008; it is representative at the country level, regional level, Bogota level and socioeconomic stratum. It includes questions on type of housing and physical conditions, access to public utilities, socio-demographic variables, health, education, and the labor market, among others. Households self-report the estimated value of their housing units and the type of tenure. Housing can be (i) owned and fully paid when one of the household members has the ownership title and does not have housing financing of any kind; (ii) owned but still being paid for; (iii) rented; (iv) in usufruct, when the household is authorized by the owner to occupy the housing unit without paying rent; and (iv) de facto occupied, when a household occupies the unit without being the owner or being authorized. If the unit was bought during the 4 years prior to the survey, the survey asks questions on funding (including own resources, mortgage, credit from friends/relatives and severance payments). In the 2003 survey we are able to know whether the household received

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<sup>12</sup> In 2009 this amount represents about 140 MLWS or us\$30.300.

a subsidy. According to these surveys, one half of households own their house and around a third are renters. One sixth of the population lives in usufruct arrangements; although very few are *de facto* occupants, this percentage increased from 1.2% in 2003 to 3.6% in 2008. Note that these proportions remain quite stable between 2003 and 2008 (Table 5).

**Table 5: Tenure Type**

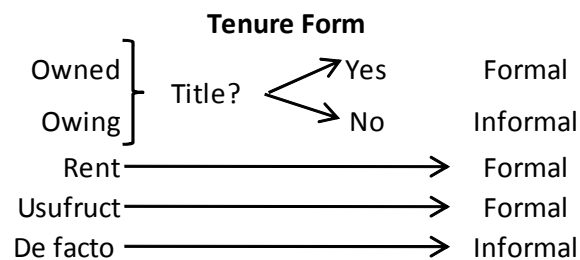
	2003		2008	
	Freq.	%	Freq.	%
Owner	10,774	52.4%	6,057	46.2%
Owing	1,202	5.8%	832	6.3%
Renters	5,807	28.2%	4,018	30.7%
Usufruct	2,530	12.3%	1,728	13.2%
De facto occupant	251	1.2%	476	3.6%

Source: 2003 and 2008 QLS

### 3.2 Definition of informal housing

One purpose of this study is to explore the determinants of households' decisions with regard to choosing to live in formal or informal housing. In this section we explain the definition of informality used throughout the paper. Usually, informal dwellings are those that comply with all legal requirements and urban regulations. In parallel with this, there are informal markets whose transaction purpose does not fit into the legal and regulatory requirements (Abramo, 2003). One way of capturing this concept is through the registration of dwellings; therefore, dwellings can be considered as formal if any member of the household has the title deed of the house. For owners interviewed in 2008 we know if the household has a property title. Using this information, we classify as informal those houses that were occupied *de facto* and those for which the owner does not have a title. Figure 1 sketches the definition.

**Figure 1: Legal Definition of Formality**





Unfortunately, the information on housing registration is only available in the 2008 QLS. As a consequence, we constructed a more elaborate definition of informality that captures different dimensions of the house, mainly related to its level of precariousness<sup>13</sup>. Dowall (2007) suggests that informal housing can be defined according to three concepts: security of tenure, access to services and physical characteristics of the structures. Based on this definition, we built a Formal Housing Index (FHI) using information from the 2003 and 2008 QLS, as a weighted average of: i) households' self-reported *de facto* tenure; ii) access to public services; and iii) physical conditions of the settlement and housing units. Following Kolenikov & Angeles (2009) and Hamill (2009), and given that we are working with discrete variables, we conducted a Principal Component Analysis using tetrachoric correlations.

In Table 6 we present the coefficients of each variable for the first principal component, which explained 30% of the variance of the data<sup>14</sup>. The signs are as expected. *De facto* tenure reduces the likelihood of being formal and increases the probability of being informal by 23%, and all settlement risks increase informality. Adequate access to utilities reduces the chance of being informal by around 30%, depending on the type of service. Among wall materials, only bricks and prefabricated materials reduce the probability of informal settlements. With regard to floor materials, marble, carpet, vinyl, tiles and bricks reduce housing informality, whereas cement, wood and dirt increase it.

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<sup>13</sup> At the end of this section we show that the legal definition based on dwelling registration using data of the 2008 QLS is highly correlated with the one we are proposing here.

<sup>14</sup> The optimal number of components was selected following two criteria: the eigenvalues must be greater than one and the optimal principal components must be located before the "elbow" of their scree plot. From the latter, available upon request, it is clear that the first component is optimal as the basis for the construction of a common multidimensional formal housing index.

**Table 6: First Component of the FHI**

	2003	2008
<b>De facto Tenure</b>	-0.2384	-0.2202
<b>Risks</b>		
Risk1: flood	-0.176	-0.1317
Risk2: avalanches, landslides or mudslides	-0.223	-0.102
Risk3: streams and overflows	-0.203	-0.0894
Risk4: land subsidence	-0.0805	n/a
<b>Utilities</b>		
Electricity	0.2967	0.3218
Adequate Toilet	0.308	0.3393
Sewerage	0.3452	0.3647
Rubbish collection	0.273	0.3467
Aqueduct	0.3071	0.3083
<b>Wall Materials</b>		
Bricks	0.2695	0.2803
Adobe	-0.096	-0.0173
Wattle	-0.0677	-0.0811
Wattle and daub	-0.0867	-0.1188
Wood	-0.1566	-0.1686
Prefabricated Material	0.0652	0.0397
Bamboo, cane, other plants	-0.1579	-0.0976
Zinc, cloth, cardboard, disposable materials	-0.1185	-0.0954
No walls		-0.0572
<b>Floor Materials</b>		
Marble (or parquet for 2003)	0.182	0.1919
Parquet		-0.009
Carpet	0.2149	0.1907
Vinyl, tiles or bricks	0.1409	0.1978
Wood or other plant	-0.1015	-0.1455
Cement	-0.1562	-0.0506
Dirt	-0.2193	-0.2473

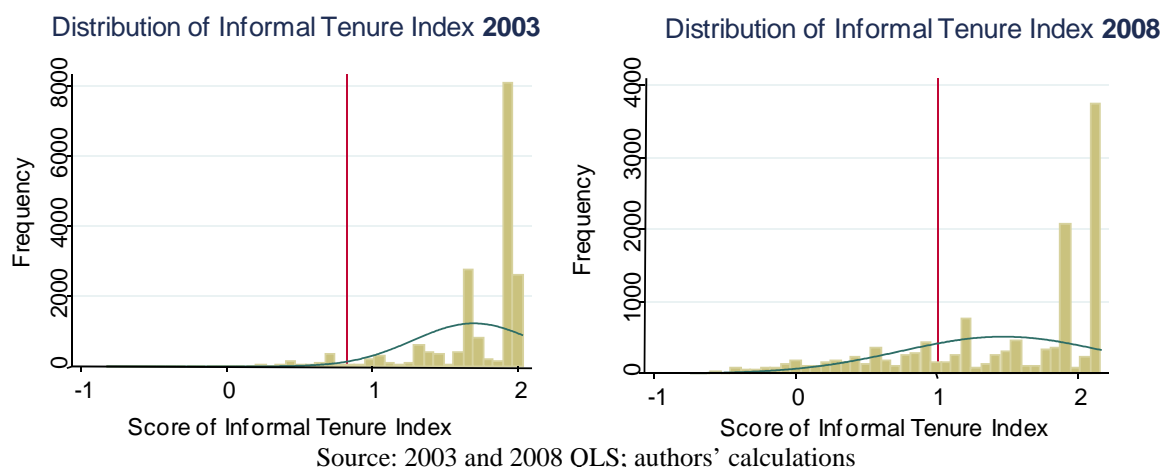
Source: 2003 and 2008 QLS; authors' calculations

We considered as living in informal housing the 20% of households registering the lowest score on the IFI distribution. This threshold is based on the percentage of slums reported by UN-Habitat (17.9%) and the qualitative housing deficit<sup>15</sup> reported in the 2005 census (23.8%). Graph 9 shows the FHI distribution and the threshold, and illustrates that the number of households on the left side of the red line add up to 20% of our sample<sup>16</sup>. Using this threshold, 17,035 households live in informal settlements, 68,112 in formal housing.

<sup>15</sup> Qualitative deficit refers to the number of households living in units with inadequate physical conditions.

<sup>16</sup> Results were robust to sensibility checks using 15% and 30% as thresholds.

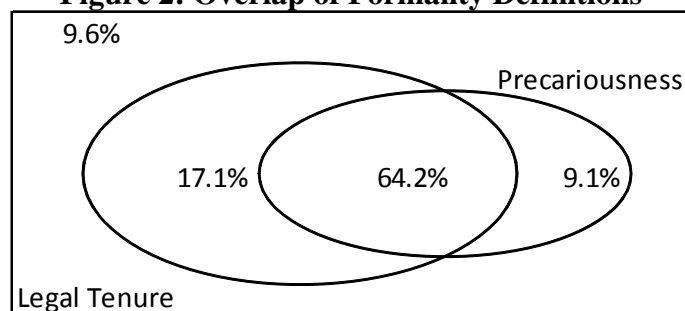
### Graph 9 : First Component of the Formal Housing Index



#### Correlation among definitions

As we stated above, our definition of formality is mostly driven by the precariousness of the housing unit rather than by the legality of its tenancy. It is worth analyzing to what extent our definition overlaps with the one based purely on the legal status of the dwelling (defined by Figure 1). Figure 2 shows that the overlap between these definitions is 73.8% --i.e. 73.8% of the houses are classified in the same category (formal or informal) by both definitions. On the other hand, 17.1% of households are legal tenants but live in precarious solutions, while 9.1% of households inhabit good quality dwellings but occupy them illegally.

**Figure 2: Overlap of Formality Definitions**



As stated above, the “legal” definition can only be constructed for 2008. Nonetheless, our definition from the FHI captures the bulk of houses considered formal/informal, according to its legal status. Thus, in the remainder of the paper we refer to precarious housing as *informal*, being confident that very likely they also do not comply with all legal requirements.

### 3.2.1 Characteristics of households

Between 2003 and 2008 the number of households renting and owning informal dwellings both increased 4%. As a result, the participation of formal owners declined 8%. Head-of-household *formal owners* tend to be married or widowed, older than 35, highly educated, with high income and belong to households with several members (Table 7). Head-of-household *renters* are mostly single, divorced or living in cohabitation, younger (between 25 and 49 years old), highly educated, belong to all income levels, have less household members and live more commonly in urban areas. Informal owners are mostly characterized by having low levels of education and for belonging to lower income quintiles and strata.

**Table 7: Households' characteristics by housing tenure status**

	Rented	Owned Informally	Owned Formally	Rented	Owned Informally	Owned Formally
	2003			2008		
<b>TOTAL</b>	32.7%	7.3%	60.1%	36.8%	11.1%	52.1%
<b>Gender</b>						
Female	30.7%	8.1%	61.2%	35.2%	7.7%	57.1%
Male	33.5%	6.9%	59.5%	37.6%	12.6%	49.8%
<b>Marital Status</b>						
Cohabitation	42.0%	7.2%	50.8%	49.1%	13.7%	37.2%
Married	26.8%	7.1%	66.1%	26.9%	10.2%	62.8%
Widowed	13.5%	8.5%	78.0%	16.5%	13.7%	69.8%
Divorced	39.6%	7.5%	52.9%	39.0%	9.2%	51.9%
Single	42.8%	7.0%	50.2%	47.4%	5.9%	46.6%
<b>Age</b>						
12-17 years	54.8%	3.2%	42.0%	43.2%	43.4%	13.3%
18-24 years	73.9%	5.0%	21.1%	68.6%	11.5%	19.9%
25-34 years	60.6%	6.2%	33.2%	67.1%	9.0%	23.9%
35-49 years	36.9%	7.3%	55.7%	40.4%	9.4%	50.1%
50-64 years	19.0%	7.6%	73.3%	23.6%	11.7%	64.8%
>65	10.2%	8.2%	81.6%	11.9%	16.0%	72.1%
<b>Education Level</b>						
None/Preschool	12.6%	9.9%	77.5%	17.5%	33.8%	48.7%
Primary (1 - 5)	24.9%	9.6%	65.5%	29.5%	17.6%	53.0%
Secondary (6 - 13)	44.8%	6.4%	48.7%	46.9%	4.5%	48.6%
Tertiary	41.0%	2.5%	56.5%	42.4%	0.9%	56.6%
Graduate	31.2%	0.9%	67.8%	24.5%	0.4%	75.1%
<b>Formality</b>						
Informal	36.2%	8.0%	55.8%	40.4%	17.5%	42.2%
Formal	37.8%	5.3%	56.9%	44.4%	1.6%	54.0%
<b>Stratum</b>						
0 <sup>17</sup>	24.2%	19.4%	56.5%	21.5%	73.9%	4.5%
1	18.8%	14.5%	66.7%	26.8%	25.8%	47.3%
2	34.5%	9.2%	56.3%	39.7%	5.1%	55.3%
3	44.1%	2.4%	53.6%	47.5%	0.4%	52.2%
4	35.3%	0.1%	64.6%	39.6%	0.0%	60.4%
5	34.2%	1.1%	64.8%	23.7%	0.0%	76.3%
6	25.1%	0.0%	74.9%	20.0%	0.0%	80.0%
Not reported	8.3%	8.1%	83.6%	37.8%	9.5%	52.7%
<b>Urban</b>						
Rural	12.7%	7.5%	79.8%	15.4%	50.9%	33.8%
Urban	38.3%	7.2%	54.4%	41.2%	3.0%	55.8%
<b>Migrant</b>						
No	28.1%	8.0%	63.9%	33.8%	15.8%	50.4%
Yes	36.3%	6.7%	57.0%	39.3%	7.2%	53.5%

Source: 2003 and 2008 QLS; authors' calculations

<sup>17</sup> Stratums are based on the classification for the definition of electricity rates. We define stratum 0 as houses with illegal connection to electricity.

Table 8 displays the sources of funding used for housing bought between 1998 and 2002 (2003 QLS) or between 2003 and 2007 (2008 QLS). These sources of funding are not mutually exclusive and percentages refer to the proportion of household who reported having used each source of funding, rather than the participation of the type of funding in the value of the house purchased. Around 80% of households used own resources in 2003, regardless of income. This proportion decreased to 60% in 2008. Interestingly, between 2003 and 2008 the number of household who used housing credit decreased significantly in the higher quintiles and increased in the lower quintiles. The same was true for severance payments.

**Table 8: Sources of Funds**

	2003					2008				
	<i>Percentage of household who used each source</i>									
	1	2	3	4	5	1	2	3	4	5
Income Quintile										
Own Resources	79.9	81.2	77.1	79.8	74.0	73.3	66.8	56.9	56.5	64.0
Housing Credit	5.8	3.2	8.9	20.4	31.2	10.2	7.6	12.8	12.4	5.0
Credit from Friends	18.2	13.2	12.7	13.3	9.4	2.4	4.4	5.6	0.6	0.1
Severance Payments	1.3	5.8	9.6	19.2	26.8	4.5	8.3	15.0	11.0	7.1
Other Resources	11.1	14.0	12.8	9.6	13.0	0.7	4.1	9.1	10.6	7.7

Source: 2003 QLS and authors' calculations

### 3.3 Tenure choice

The purpose of this exercise is to identify the variables behind households' decisions whether to own or rent, and whether to live in an informal or a formal settlement. Since very few households rent informal dwellings, we estimate a multinomial logistic regression in which households can choose to rent, own informally or own formally. The decision depends on socioeconomic and other exogenous characteristics. Policy can also play a role: households ranking in the lowest living conditions (0 to 2 according to SISBEN classification) or with incomes below four minimum wages can apply for Social Housing Subsidies. Among eligible households, only those who *decide* to buy their dwelling receive the subsidy, while there is no subsidy for those who rent. The general specification is as follows:

$$\Pr(y_i = \text{"Rented"}) = \frac{1}{1 + \sum_{j=1}^2 \exp(X_i \beta_j)} + \varepsilon_i \quad (1)$$

$$\Pr(y_i = \text{"Owned Informally"}) = \frac{\exp(X_i \beta_1)}{1 + \sum_{j=1}^2 \exp(X_i \beta_j)} + \varepsilon_i \quad (2)$$

$$\Pr (y_i = \text{"Owned Formally"}_i) = \frac{\exp (X_i \beta_2)}{1 + \sum_{j=1}^2 \exp (X_i \beta_j)} + \varepsilon_i \quad (3)$$

where  $X_i$  is a vector of exogenous household characteristics which includes household head's characteristics such as gender, marital status, age, education level, migration and employment status<sup>18</sup>, and other household characteristics such as income, geographical location, number of household members, a wealth proxy calculated as a composite index of variables showing the possession of durable goods (washing machines, refrigerators, stoves, computers, vehicles and blenders) and whether the household lives in urban or rural areas.

Table 9 reports the relative risk ratios of the probabilities for every combination of owning formally, owing informally or renting<sup>19</sup>. Each panel of the table refers to a dimension of the tenure choice. Dimensions considered are the household head's socio-demographic characteristics (Panel A), human capital and wealth (B), employment status (C) and other relevant variables (D). The main results can be summarized as follows:

**Household head's socio-demographic characteristics.** Household head's gender, marital status and age have an impact on the choice of tenure. Males rent or purchase informal dwellings more frequently than females. For individuals who live or used to live as a couple (i.e. married/cohabitation and widowed/divorced) the probability of renting is higher than that of purchasing<sup>20</sup>. Finally, older heads of households are more prone to buy housing (formal and informal) than to rent, and purchased houses tend to be more formal.

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<sup>18</sup> Household heads can be inactive, unemployed or employed. If she or he is employed she can be formal if she is affiliated with a pension fund and has a work contract; otherwise she is informal.

<sup>19</sup> The relative risk ratio (RRR) of a coefficient indicates how the risk of the outcome falling in the comparison group compared to the risk of the outcome falling in the referent group changes with the variable in question. A  $RRR > 1$  indicates that the risk of the outcome falling in the comparison group relative to the risk of the outcome falling in the referent group increases as the variable increases. In other words, the comparison outcome is more likely. A  $RRR < 1$  indicates that the risk of the outcome falling in the comparison group relative to the risk of the outcome falling in the referent group decreases as the variable increases.

<sup>20</sup> The omitted category of the marital status is "single".

**Table 9: Tenure Choice**  
**Panel A – Household Head’s Socio-demographic Characteristics**  
**1= Rented; 2= Owned Informally; 3= Owned Formally**

Relative Risk Ratios	Male		Married/Cohabitation		Widowed/Divorced		Age	
	2003	2008	2003	2008	2003	2008	2003	2008
<b>2 to 1</b>	0.914 (0.100)	1.200 (0.138)	0.662*** (0.098)	1.028 (0.161)	0.620*** (0.090)	1.161 (0.189)	1.059*** (0.003)	1.055*** (0.003)
<b>3 to 1</b>	0.901* (0.049)	0.895 (0.065)	0.744*** (0.052)	0.701*** (0.067)	0.720*** (0.051)	0.670*** (0.065)	1.070*** (0.002)	1.067*** (0.002)
<b>1 to 2</b>	1.094 (0.119)	0.834 (0.096)	1.510*** (0.224)	0.972 (0.153)	1.613*** (0.234)	0.862 (0.140)	0.944*** (0.003)	0.948*** (0.003)
<b>3 to 2</b>	0.986 (0.103)	0.746*** (0.080)	1.123 (0.162)	0.681*** (0.101)	1.161 (0.163)	0.577*** (0.088)	1.011*** (0.003)	1.011*** (0.003)
<b>1 to 3</b>	1.110* (0.061)	1.117 (0.081)	1.344*** (0.095)	1.427*** (0.136)	1.389*** (0.097)	1.493*** (0.145)	0.934*** (0.002)	0.938*** (0.002)
<b>2 to 3</b>	1.015 (0.106)	1.341*** (0.143)	0.890 (0.128)	1.468*** (0.218)	0.861 (0.121)	1.733*** (0.265)	0.989*** (0.003)	0.989*** (0.003)
Observations	18034	10291						

Standard errors in parenthesis; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1; Regional dummies included

**Human capital and wealth.** Educated individuals are more prone to rent a house; however, when they purchase, the likelihood of buying a formal dwelling is higher than of buying an informal one. On the contrary, households with higher income have a higher probability of buying a house than of renting it, and tend to buy formal dwellings. Finally, as expected, the probability of purchasing a house by more wealthy households (measured by the possession of assets) is by far higher than renting.



## Panel B – Human Capital, Wealth and Income

1= Rented; 2= Owned Informally; 3= Owned Formally

Relative Risk Ratios	Education		Ln(Income)		Wealth Proxy	
	2003	2008	2003	2008	2003	2008
<b>2 to 1</b>	0.934*** (0.010)	0.916*** (0.012)	1.116** (0.054)	1.085 (0.054)	2.532*** (0.225)	0.488*** (0.039)
<b>3 to 1</b>	0.972*** (0.005)	0.959*** (0.007)	1.400*** (0.037)	1.271*** (0.046)	2.238*** (0.103)	2.102*** (0.118)
<b>1 to 2</b>	1.070*** (0.012)	1.092*** (0.014)	0.896** (0.043)	0.922 (0.046)	0.395*** (0.035)	2.049*** (0.165)
<b>3 to 2</b>	1.040*** (0.011)	1.046*** (0.013)	1.254*** (0.057)	1.172*** (0.052)	0.884 (0.074)	4.306*** (0.321)
<b>1 to 3</b>	1.029*** (0.006)	1.043*** (0.008)	0.714*** (0.019)	0.787*** (0.029)	0.447*** (0.021)	0.476*** (0.027)
<b>2 to 3</b>	0.961*** (0.010)	0.956*** (0.012)	0.797*** (0.036)	0.853*** (0.038)	1.132 (0.095)	0.232*** (0.017)
Observations	18034	10291				

Standard errors in parenthesis; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1; Regional dummies included

**Employment status:** Informal employees have a higher probability of owning informal dwellings vis á vis formal employees.<sup>21</sup> This probability is statistically higher than that of renting and buying formally. Unemployment does not seem to have an impact on tenure decision; we do not observe significant differences in tenure choice between employed and unemployed. Finally, inactive household heads are more frequently owners (formal or informal) than formal workers.

<sup>21</sup> The omitted category is unemployment.

### Panel C – Employment Status

1= Rented; 2= Owned Informally; 3= Owned Formally

Relative Risk Ratios	Informal Worker		Unemployed		Inactive	
	2003	2008	2003	2008	2003	2008
<b>2 to 1</b>	0.829* (0.087)	1.745*** (0.273)	1.281 (0.241)	1.388 (0.377)	1.330** (0.180)	2.089*** (0.394)
<b>3 to 1</b>	0.750*** (0.036)	0.853** (0.058)	1.258** (0.117)	1.201 (0.172)	1.326*** (0.091)	1.426*** (0.137)
<b>1 to 2</b>	1.207* (0.126)	0.573*** (0.090)	0.781 (0.147)	0.721 (0.196)	0.752** (0.102)	0.479*** (0.090)
<b>3 to 2</b>	0.905 (0.093)	0.489*** (0.074)	0.982 (0.179)	0.865 (0.226)	0.997 (0.127)	0.683** (0.121)
<b>1 to 3</b>	1.333*** (0.063)	1.172** (0.079)	0.795** (0.074)	0.833 (0.119)	0.754*** (0.052)	0.701*** (0.067)
<b>2 to 3</b>	1.105 (0.113)	2.045*** (0.311)	1.018 (0.186)	1.156 (0.302)	1.003 (0.128)	1.465** (0.259)
Observations	18034	10291				

Standard errors in parenthesis; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1; Regional dummies included

**Other relevant variables:** Migrant households rent more often and there are not significant differences in the formality of ownership. Households living in urban areas have a much higher likelihood of renting. Households with large number of members are more frequently owners; however, it is more likely that the properties are informal. Finally, the eligibility for a subsidy increases the probability of buying a house, either formal or informal. The positive impact means that, other things equal, the proportion of households purchasing housing vis á vis the renters is higher among households eligible for a subsidy as compared to total population. It could be argued that since eligibility is highly correlated with poverty, this variable would be endogenous and its effect would be biased. Nonetheless, it is expected that poorer households are less likely to buy. Therefore, if the bias exists, the impact of the subsidy would be, if anything, underestimated

### Panel D – Other Relevant Variables

1= Rented; 2= Owned Informally; 3= Owned Formally

Relative Risk Ratios	Migrant		Urban		Number of Household Members		Eligibility for Subsidies	
	2003	2008	2003	2008	2003	2008	2003	2008
<b>2 to 1</b>	0.658*** (0.050)	0.587*** (0.046)	0.340*** (0.039)	0.052*** (0.005)	1.150*** (0.023)	1.120*** (0.024)	6.027*** (0.635)	1.353 (0.306)
<b>3 to 1</b>	0.694*** (0.028)	0.615*** (0.032)	0.110*** (0.009)	0.497*** (0.034)	1.096*** (0.014)	1.079*** (0.017)	1.707*** (0.084)	1.157* (0.101)
<b>1 to 2</b>	1.520*** (0.117)	1.704*** (0.134)	2.940*** (0.338)	19.248*** (1.954)	0.870*** (0.017)	0.893*** (0.019)	0.166*** (0.017)	0.739 (0.167)
<b>3 to 2</b>	1.055 (0.077)	1.049 (0.076)	0.324*** (0.032)	9.557*** (0.889)	0.953*** (0.017)	0.963** (0.018)	0.283*** (0.029)	0.856 (0.187)
<b>1 to 3</b>	1.442*** (0.058)	1.625*** (0.085)	9.064*** (0.711)	2.014*** (0.138)	0.912*** (0.011)	0.927*** (0.015)	0.586*** (0.029)	0.864* (0.075)
<b>2 to 3</b>	0.948 (0.069)	0.954 (0.070)	3.084*** (0.303)	0.105*** (0.010)	1.049*** (0.019)	1.038** (0.019)	3.530*** (0.360)	1.169 (0.255)
Observations	18034	10291						

Standard errors in parenthesis; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1; Regional dummies included

### 3.4 Housing demand

In order to estimate housing demand we adapted a model proposed by Fontela and Gonzalez (2008) for the Mexican market. The general model is as follows: let  $q_{ij} = q(p_j, m_{ij}, X_i)$  be the demand function for housing of household  $i$  in market  $j$ <sup>22</sup>. The model specification is:

$$q_{ij} = \alpha_0 + \alpha_1 p_j + \alpha_2 m_{ij} + \alpha_3 mt_{ij} + \alpha_4 X_i + \alpha_5 Y_i + \varepsilon \quad (4)$$

where  $q_{ij}$  is the housing quantity demanded by household  $i$  in market  $j$ ;  $p_j$  is the housing price index in market  $j$ ;  $m_{ij}$  is the permanent income of household  $i$  in market  $j$ ;  $mt_{ij}$  is the transitory income of household  $i$  in market  $j$ ;  $X_i$  is a vector of exogenous household characteristics, including the household head's characteristics and other household characteristics); and  $Y_i$  is a vector of variables related to the source of funding of the unit (own resources, housing credit, credit from friends/ relatives, severance payments, other resources. In order to say something about policy, we include subsidy and eligibility for subsidies in vector  $Y_i$ , according to data availability. With information from the 2003 QLS we know if household  $i$  received a subsidy for the purchase or construction of a housing unit or plot of land during the 4 years that precede the survey. With information of both the 2003 and 2008 QLS, we know which households are eligible for social housing subsidies (i.e.: those that rank in the lowest levels of SISBEN or earn less than 4 minimum wages).

#### 3.4.1 Permanent and temporary income

Temporary and permanent income are key determinants of housing demand. In order to distinguish between the two, we assume that temporary income may be explained by a set of observable characteristics. The part of income not explained by these variables is assumed to be transitory. To estimate the permanent and transitory we use household demographic characteristics and control variables. The model specification is:

$$m_i = \theta_0 + \theta_1 X_i + \varepsilon_i \quad (5)$$

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<sup>22</sup> The markets are defined according to the geographical location of the housing units. Since the QLS is representative only for the city of Bogotá and for a group of 8 regions, we will take those regions as markets. The regions are Atlantic, Eastern, Central, Pacific, Antioquia, Valle, San Andrés and Orinoquía-Amazonas.

where  $X_i$  is a vector of exogenous household head characteristics such as gender, marital status, age, education level and employment status (formally/informally employed, unemployed, inactive); and other characteristics which are geographical location and number of household members. Results are displayed in Table 10.

Surprisingly, in our sample there is no significant difference in monthly earnings between men and women for 2003. With that exception, all variables have the expected sign and are significant. As expected, income increases monotonically (with diminishing marginal returns) with age and with education. For instance, an average individual with tertiary education earns 160% more than one with no education. With regard to labor status, we find that informal workers earn between 35% and 40% less than formal employees, the unemployed around 80% less and the inactive population's income is similar to the average earnings of informal employees. Finally, as expected, larger households have higher incomes.

**Table 10: Income estimation**

VARIABLES	2003	2008
	(1) MCO	(1) MCO
<i>Gender (female is omitted)</i>		
Male	0.0512 (0.032)	0.118*** (0.031)
<i>Marital Status (Cohabitation is omitted)</i>		
Married	0.137*** (0.024)	0.153*** (0.025)
Widowed	0.00693 (0.046)	0.127** (0.049)
Divorced	-0.0488 (0.041)	-0.0727* (-0.04)
Single	-0.158*** (0.041)	-0.0681 (0.042)
Age	0.0403*** (0.004)	0.0284*** (0.004)
Age^2	-0.000278*** (0)	-0.000154*** (0)
<i>Education Level (None/preschool is omitted)</i>		
Primary (1 - 5)	0.470*** (0.036)	0.434*** (0.037)
Secondary (6 - 13)	1.058*** (0.039)	0.909*** (-0.04)
Tertiary (univ/technical)	1.632*** (0.046)	1.566*** (0.051)
Graduate	2.139*** (0.059)	2.343*** (0.071)
<i>Labor classification (Formal worker is omitted)</i>		
Informal worker	-0.402*** (0.025)	-0.347*** (0.026)
Unemployed	-0.770*** (0.059)	-0.842*** (0.073)
Inactive	-0.221*** (0.036)	-0.328*** (0.042)
Region Controls		
Number of Household Members	Yes 0.115*** (0.031)	Yes 0.119*** (0.038)
Constant	11.57*** (0.031)	12.13*** (0.035)
Observations	20480	12686
R-squared	0.409	0.387

Robust (clustered) standard errors in parentheses

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

### 3.4.2 Hedonic prices

Since our objective is to estimate a housing demand and therefore to identify the effect of prices, we need to construct different prices for similar housing. This can be done assuming that the prices of houses do not depend only on their physical characteristics, but also on the characteristics of their environment (Fontenla and Gonzalez, 2009). Consequently, the latter segments the housing market. Colombia is an interesting case study given that housing environmental characteristics are taken into account in defining housing strata, a measure that is used to focus cross subsidies on public services payments. Moreover, the data we use are representative at strata levels, which allows us to identify each stratum in a different market and to estimate the price of average housing in each of these markets. Based on these prices, we are able to construct a measure of the quantity of housing demanded.

Given that  $q_{ij}$ , the quantity of housing demanded by household  $i$  in market  $j$ , is not observable, but that we do observe a housing unit's value at the moment of its purchase, we will use a hedonic price estimation to obtain  $q_{ij}$ . The hedonic price technique specifies a model in which the dependent variable is the housing unit's market value and the independent variables are the characteristics of the housing unit and some control variables. We define the value of housing unit  $n$  in market  $j$  as:

$$v_{nj}^i = v(H_n, D_n, \beta_j) \quad (6)$$

The specification of the econometric model is:

$$v_{nj}^i = \beta_j H_n + \delta_j D_n + \varepsilon \quad (7)$$

where  $v_{nj}^i$  is the price that household  $i$  in market  $j$  paid for the unit  $n$  at the moment of its purchase;  $H_n$  is a vector of the housing unit's characteristics and controls for housing demand determinants. Housing characteristics include construction materials, number of bedrooms, access to utilities and amenities, geographical location, occurrence of floods, land subsidence, etc., and nearby risk locations such as landfills, airports, communication antennas, etc. To control for housing demand determinants, we include the household's permanent and transitory income, the education level, age, civil status and gender of the household's head.  $\beta_j$  is the vector of the marginal contributions of each housing attribute to the price of the

housing unit. This vector of parameters varies across markets for each of the housing unit characteristics in  $H_n$ . The estimated marginal contributions are presented in the Appendix.

Once we have estimated  $\beta'_j$  of implicit prices for each characteristic, we are able to calculate the price of an average housing unit (a unit with average characteristics). Market  $j$  price index  $p_j$  is constructed as:

$$p_j = 100 * \frac{v(H_n^*, \beta_j)}{v(H_n^*, \beta_3)} \quad (8)$$

where the value of stratum 3 ( $j=3$ ) index is set equal to 100. The price index is reported in Table 11. We also report observed market values.

**Table 11: Price Index by Stratum**

<i>Panel A: Owners</i>				
<b>Stratum</b>	<b>2003</b>		<b>2008</b>	
	<b>Hedonic Price</b>	<b>Self-Reported Value</b>	<b>Hedonic Price</b>	<b>Self-Reported Value</b>
<i>Price index, stratum 3= 100</i>				
1	53.1	23.5	39.7	21.1
2	60.9	51.9	52.7	45.5
3	100.0	100.0	100.0	100.0
4	158.3	171.5	425.9	176.4
5 and 6	426.7	275.0	458.3	280.7
		471.1		472.8

<i>Panel B: Renters</i>				
<b>Stratum</b>	<b>2003</b>		<b>2008</b>	
	<b>Hedonic Price</b>	<b>Self-Reported Value</b>	<b>Hedonic Price</b>	<b>Self-Reported Value</b>
<i>Price index, stratum 3= 100</i>				
1	73.7	41.5	60.4	41.0
2	77.0	62.5	70.7	60.5
3	100.0	100.0	100.0	100.0
4	199.3	181.9	104.6	180.1
5 and 6	229.2	242.2	640.6	247.9
		422.2		433.0

Source: QLS 2003 and 2008; authors' calculations

Self-reported values in Panel A (owners) and in Panel B (renters) reflect both the prices and the quantities of attributes. Since the hedonic price index and the index of self-assessed



values move in parallel, it has to be the case that differences in values are mostly explained by differences in prices. In other words, house attributes are similar within each market.

The value of the housing unit  $n$  in market  $j$  consumed by household  $i$  can be expressed as  $v_{nj}^i = q_{ij} * p_j$ . Therefore, the quantity of housing for each household equals the ratio between the housing unit value and the estimated relevant price index:

$$q_{ij} = \frac{v_{nj}^i}{p_j} \quad (9)$$

### 3.4.3 Results of the housing demand estimation

To estimate housing demand we followed equation (5) and the above-defined variables. We estimate separately the demand for home purchase and for rentals. We therefore report two different specifications for each year (Table 12)<sup>23</sup>. The main results are the following:

#### Price elasticity:

1. Is negative and significant in all specifications.
2. As expected, an increase in the price of the substitute increases demand. Moreover, when including the price of the substitute, the own-price elasticity increases (in absolute value) quite significantly. These estimations are within the broad ranges reported in the literature reviewed by Malpezzi (1999) where elasticities range from close to 0 (Follain *et al*, 1980) to -1 (Malpezzi and Mayo, 1987). To the best of our knowledge, prior studies do not control for the price of substitutes. As can be seen in Table 12, this can severely bias the results.
3. For both renters and buyers the price elasticity increased between 2003 and 2008.
4. In general, the demand for rental housing responds slightly less to price changes than the demand for purchased housing.

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<sup>23</sup> It is possible for formal and for informal houses markets to be perfectly segmented. In that case, one market could behave very differently from the other. In that case, there is merit in estimating separate demand functions for each of them. Nonetheless, this is not possible because of the way in which we separate housing markets; our different markets are socioeconomic strata (instead of regions) and housing informality is concentrated only in the two lowest strata. As a result, there are not enough informal houses in higher strata to estimate separately prices for formal and informal houses. Moreover, restricting the estimation to the two lowest strata would not generate enough variation in order to accurately estimate price elasticities.

### Income elasticity:

1. The row log (Permanent Income) shows the elasticity for non-formally working household heads (informal workers, unemployed or inactive workers). For these workers the income elasticity hovers around 0.5 and there are no significant differences between the demands for buying and for renting. They are close to the mid-point of the range of previous estimates for Colombia (Ingram, 1984; Assadian and Ondrich, 1993) and for other developing countries.
2. For formal workers, the income elasticity is smaller in one to two percentage points. These differences are, in general, statistically significant.
3. Demand elasticity to transitory income hovers around 0.3. This is similar to what Chou and Shih (1995) report for Hong-Kong, but much higher than the 0.04 reported by Fontenla and Gonzalez (2009) in the case of Mexico.
4. We allow shocks to income to have an asymmetric effect. In general, demand is more sensitive to positive shocks than it is to negative ones.

**Table 12: Housing Demand Estimation**

VARIABLES	2003				2008			
	(1) Owned Units	(2) Owned Units	(3) Rented Units	(4) Rented Units	(5) Owned Units	(6) Owned Units	(7) Rented Units	(8) Rented Units
Log(Price)	-0.34*** (0.052)	-0.84*** (0.107)	-0.24*** (0.069)	-0.80*** (0.133)	-0.64*** (0.068)	-1.13*** (0.108)	-0.61*** (0.092)	-0.98*** (0.105)
Log(Substitute Price)		1.09*** (0.180)		0.31*** (0.073)		1.19*** (0.175)		0.29*** (0.043)
Log(Permanent Income)	0.52*** (0.048)	0.52*** (0.047)	0.54*** (0.040)	0.53*** (0.040)	0.40*** (0.075)	0.38*** (0.075)	0.51*** (0.040)	0.50*** (0.040)
Log(Perm. Inc)XFor. worker	-0.20*** (0.045)	-0.20*** (0.044)	-0.10** (0.047)	-0.09** (0.047)	-0.08 (0.086)	-0.10 (0.086)	-0.13*** (0.045)	-0.16*** (0.044)
Log(Transitory Inc.>0)	0.30*** (0.038)	0.31*** (0.038)	0.35*** (0.041)	0.35*** (0.041)	0.37*** (0.061)	0.36*** (0.060)	0.29*** (0.033)	0.27*** (0.032)
Log(Transitory Inc.<0)	-0.22*** (0.033)	-0.22*** (0.032)	-0.11*** (0.023)	-0.11*** (0.023)	-0.14*** (0.047)	-0.14*** (0.047)	-0.13*** (0.029)	-0.12*** (0.029)
Age	0.01*** (0.001)	0.01*** (0.001)	0.00 (0.001)	0.00 (0.001)	0.00** (0.002)	0.00* (0.002)	-0.00 (0.001)	-0.00 (0.001)
Gender	-0.01 (0.045)	-0.01 (0.044)	-0.08** (0.034)	-0.08** (0.033)	0.03 (0.060)	0.03 (0.059)	-0.05 (0.033)	-0.05 (0.033)
Education	0.01** (0.006)	0.01* (0.006)	-0.00 (0.005)	-0.00 (0.004)	0.01 (0.009)	0.01 (0.009)	-0.00 (0.005)	-0.01 (0.005)
<i>Marital Status (Single omitted)</i>								
Married/Cohabitation	-0.20*** (0.053)	-0.19*** (0.052)	-0.08* (0.045)	-0.07 (0.045)	-0.16** (0.075)	-0.15** (0.074)	-0.03 (0.042)	-0.01 (0.041)
Widowed/Divorced	-0.15*** (0.054)	-0.14*** (0.053)	-0.11** (0.043)	-0.11** (0.043)	-0.12 (0.085)	-0.13 (0.083)	-0.02 (0.045)	-0.01 (0.044)
Urban	0.87*** (0.040)	0.86*** (0.040)	0.72*** (0.057)	0.72*** (0.057)	0.40*** (0.048)	0.36*** (0.048)	0.58*** (0.044)	0.59*** (0.044)
Social Housing	-0.20*** (0.042)	-0.18*** (0.041)	0.03 (0.041)	0.03 (0.040)	-0.23*** (0.066)	-0.12* (0.066)	-0.21*** (0.035)	-0.20*** (0.036)
<i>Employment Status (Formal worker omitted)</i>								
Informal Worker	-2.89*** (0.642)	-2.77*** (0.638)	-1.23* (0.661)	-1.20* (0.656)	-1.19 (1.239)	-1.39 (1.233)	-1.75*** (0.645)	-2.13*** (0.630)
Unemployed	-2.59*** (0.642)	-2.48*** (0.637)	-1.05 (0.651)	-1.02 (0.646)	-0.89 (1.230)	-1.12 (1.224)	-1.47** (0.638)	-1.85*** (0.623)
Inactive	-2.83*** (0.647)	-2.72*** (0.642)	-1.26* (0.666)	-1.23* (0.661)	-1.05 (1.248)	-1.25 (1.242)	-1.67*** (0.646)	-2.06*** (0.631)
Constant	12.86*** (0.911)	8.21*** (1.174)	3.42*** (1.086)	4.94*** (1.008)	18.58*** (1.569)	13.08*** (1.664)	9.38*** (1.233)	9.40*** (1.249)
Observations	10481	10481	6648	6648	5982	5982	3125	3125
R-squared	0.395	0.400	0.373	0.377	0.099	0.112	0.301	0.314

Robust standard errors in parentheses

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

### Sources of financing:

1. Questions regarding financing are only available for households who actually did buy a house, not for the entire sample. Therefore, selection bias issues could certainly arise. To account for this, in columns (1) and (2) and in (5) and (6) of Table 13 we run the same regression, first for the entire sample and then only for those households that do report sources of financing.
2. Coefficients in columns (1) and (2), and (5) and (6) are similar, suggesting that selection bias is not a big issue when we restrict the sample to include only those households that report sources of financing.
3. The estimation for 2003 shows that the subsidy had a positive effect on demand. In particular, access to the subsidy increased demand by around 22%. We cannot estimate the effect of access to the subsidy in 2008 as the information is not available.
4. In order to compare the impact of credit with that of saving on the demand for housing, we constructed “credit” as a dummy variable equal to 1 if the household used credit from the constructor or from a financial institution, 0 otherwise; and a dummy for “savings”, equal to 1 if the household used severance payments or programmed savings, 0 otherwise. The incidence of credit has a large effect, close to 25% for 2003 and 2008 (columns 3 and 7). Savings does not any impact in 2003, but has an impact similar to that observed in the case of credit in 2008 (columns 3 and 7).
5. When we allow for heterogeneous effects of financing sources on social and non-social households (columns 4 to 8), credit does not have any impact on households non-eligible for subsidies. On the contrary, the impact for non-social households is quite high: on account of having credit, demand was 40% higher in 2003 and 60% in 2008. With respect to savings, we do not observe an impact in any of the two groups. In 2008 the effect of savings is observed only among social-housing households: although the coefficients of savings and the interaction are not significant, the sum of the two variables – i.e. the impact over social-housing households – is significant.

**Table 13: Sources of Funding and Demand**

Regression of the Housing Quantity								
VARIABLES	2003				2008			
	(1) <i>Entire Sample</i>	(2) Units purchased between 1998 and 2002	(3)	(4)	(5) <i>Entire Sample</i>	(6) Units purchased between 2003 and 2007	(7)	(8)
<b>Standard Demand Variables</b>								
Ln(Price)	-0.84*** (0.107)	-0.52** (0.212)	-0.53** (0.222)	-0.47** (0.204)	-1.13*** (0.108)	-1.02*** (0.174)	-1.00*** (0.176)	-1.01*** (0.180)
Ln(Substitute Price)	1.09*** (0.180)	0.67* (0.351)	0.71* (0.371)	0.61* (0.342)	1.19*** (0.175)	1.02*** (0.348)	0.98*** (0.353)	0.99*** (0.338)
Ln(Permanent Income)	0.52*** (0.047)	0.44*** (0.126)	0.44*** (0.129)	0.39*** (0.129)	0.38*** (0.075)	0.61*** (0.143)	0.58*** (0.143)	0.53*** (0.142)
Ln(Per. Income)*Form. Worker	-0.20*** (0.044)	-0.17 (0.130)	-0.19 (0.130)	-0.15 (0.131)	-0.10 (0.086)	-0.79*** (0.235)	-0.78*** (0.235)	-0.70*** (0.233)
Ln(Transitory Income>0)	0.31*** (0.038)	0.35*** (0.084)	0.33*** (0.086)	0.31*** (0.087)	0.36*** (0.060)	0.30*** (0.116)	0.32*** (0.115)	0.29** (0.116)
Ln(Transitory Income<0)	-0.22*** (0.032)	-0.26*** (0.095)	-0.26*** (0.095)	-0.25*** (0.095)	-0.14*** (0.047)	-0.05 (0.087)	-0.05 (0.087)	-0.08 (0.084)
Social Housing	-0.18*** (0.041)	-0.50*** (0.117)	-0.47*** (0.120)	-0.62*** (0.139)	-0.12* (0.066)	-0.30** (0.124)	-0.29** (0.125)	-0.50*** (0.135)
<b>Sources of Funding</b>								
Subsidy			0.22* (0.126)	0.21* (0.126)				Not available
Credit			0.22** (0.097)	-0.05 (0.108)			0.25** (0.106)	-0.04 (0.163)
CreditXSocial Housing				0.45** (0.184)				0.64*** (0.197)
Savings			0.04 (0.078)	-0.03 (0.105)			0.24* (0.132)	0.03 (0.212)
SavingsXSocial Housing				0.15 (0.151)				0.37 (0.252)
Observations	10481	1156	1156	1156	5982	906	906	906
R-squared	0.400	0.407	0.414	0.422	0.112	0.253	0.265	0.282

Bootstrapped standard errors in parentheses, controls of age, gender, education, marital status, migration, employment status and area are include. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### 4 CONCLUSIONS AND POLICY RECOMMENDATIONS

We have undertaken several econometric exercises to identify factors that affect housing tenure decisions (renting, formal ownership or informal ownership) and the demand for rentals and for purchases. The main results and policy implications are the following:

- (i) Variables that affect the choice between buying and renting are civil status, education, age of the household head, number of members in the household and whether the household resides in an urban or in a rural area. Households with higher income are more likely to purchase than to rent and the choice of formal housing is positively associated with household wealth.
- (ii) The labor market also influences tenure choice. Those working in the informal sector are more likely to purchase informal dwellings.
- (iii) Interestingly, households eligible for social housing subsidies are more likely to purchase than to rent.
- (iv) The demand for home buying is quite responsive to price changes as well as to changes in the price of rentals (its closest substitute), and the same happens in the case of the demand for rentals.
- (v) The elasticity to permanent income for both buying and renting is similar to that observed in other developing countries, and is higher for those working in the informal sector. Subsidies and other policy interventions aimed at fostering demand preferably should not include conditions that exclude people that hold informal sector jobs.
- (vi) On the other hand, demand is highly responsive to positive shocks to income, much more than in other developing countries. This finding is probably associated with the fact that access to credit is highly restricted and credit constraints are binding.
- (vii) We find that subsidies have a positive (and large) impact on housing demand.
- (viii) Likewise, access to credit (as defined above) is an important determinant of demand, and policies that favor credit expansion would seem to make sense. Finally, access to savings also has a positive effect on demand in 2008, not in 2003. A plausible explanation to this finding is that a policy intervention that began in 2000 –i.e, tax exemptions for households that established certain savings accounts destined for housing purchases—only had an important effect (similar, in magnitude, to the one already described in the case of subsidies) in the upper part of the business cycle.
- (ix) In both cases (that is, in the case of credit and in the case of subsidies) the positive effect on demand is entirely explained by demand for social housing.

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## Appendix - Marginal Contribution for Hedonic Prices

### 1. Hedonic Regression - Buyers - 2003

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
Formal	-0.102 (0.0791)	-0.0160 (0.0607)	-0.0105 (0.107)	-0.381 (0.363)	0.496** (0.213)
Urban	0.401*** (0.0692)	0.152*** (0.0584)	0.162 (0.158)		-0.638 (0.451)
<b>Type Of Unit</b>					
Apartment	0.104 (0.0879)	0.0508 (0.0463)	0.0120 (0.0529)	-0.0749 (0.133)	-0.372** (0.164)
Room(s) in tenancy	0.326* (0.190)	-0.162 (0.223)	0.571*** (0.175)		
Room(s) in other structure	-0.214* (0.116)	-0.486** (0.208)	0.444* (0.242)	-1.212*** (0.463)	
<b>Wall Materials (bricks omitted)</b>					
Adobe	-0.628*** (0.120)	-0.446*** (0.0896)	0.0544 (0.156)	0.594*** (0.203)	
Wattle	-0.507*** (0.0900)	-0.512*** (0.111)	-0.261 (0.198)		
Wattle and Daub	-0.869*** (0.128)	-0.709*** (0.201)	0.409*** (0.147)		
Coarse Wood	-0.376*** (0.0933)	-0.857*** (0.165)	-0.000971 (0.303)	0.203 (0.229)	
Prefabricated Material	0.104 (0.175)	-0.333*** (0.0896)	-0.158* (0.0917)	0.700*** (0.121)	-0.935** (0.458)
Bamboo, Cane, Another Plant	-0.992*** (0.221)	-1.091*** (0.397)			
Zinc, Cloth, Cardboard, Disposable Materials	-0.250 (0.185)	-1.050*** (0.330)			
<b>Floor Materials (Parquet, Marble omitted)</b>					
Carpet	1.044 (0.673)	-1.082 (0.713)	-0.124* (0.0712)	-0.139 (0.123)	-0.339** (0.170)
Vinyl, Tiles, Bricks	0.279 (0.233)	0.0441 (0.114)	-0.0981 (0.0627)	0.0502 (0.191)	-0.284 (0.230)
Coarse Wood, Other Plant	-0.180 (0.252)	0.133 (0.153)	-0.155 (0.116)	0.444* (0.235)	0.921 (0.632)
Cement	-0.306 (0.236)	-0.342*** (0.114)	-0.384*** (0.0754)	0.788* (0.475)	-1.026*** (0.343)
Dirt	-0.631*** (0.242)	-0.488*** (0.142)	0.115 (0.146)		
<b>Type of Toilet (toilet connected to sewerage omitted)</b>					
Toilet connected to septic tank	0.207 (0.190)	-0.106 (0.276)	0.494** (0.234)	1.814*** (0.561)	-0.404 (0.247)
Disconnected toilet	0.266 (0.206)	-0.0799 (0.289)	-0.297 (0.289)		

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
Latrine	-0.0864 (0.198)	-0.632** (0.288)	-0.829 (0.519)		
Low tide	0.307 (0.267)	0.0856 (0.409)			
No toilet	-0.143 (0.199)	-0.501* (0.287)	-0.649 (0.405)		
<b>Housing Utilities</b>					
Natural gas	0.184** (0.0801)	0.127*** (0.0483)	0.128*** (0.0496)	0.113 (0.0758)	0.325** (0.156)
Aqueduct	0.143** (0.0619)	0.110 (0.0701)	0.318 (0.194)	0.0518 (0.421)	-1.354 (0.891)
Sewerage	0.0504 (0.183)	-0.0579 (0.276)	0.170 (0.247)	1.734*** (0.576)	-0.966** (0.429)
Rubbish collection	0.212** (0.105)	0.235*** (0.0708)	0.243 (0.183)	1.977*** (0.472)	
<b>Housing Amenities</b>					
Garden or courtyard	-0.0874 (0.0650)	0.0850** (0.0386)	0.120*** (0.0458)	0.146 (0.113)	0.293** (0.139)
Lot or plot	-0.131** (0.0611)	-0.0339 (0.0551)	-0.173** (0.0880)	0.481 (0.295)	0.383** (0.161)
Garage or parking place	-0.0426 (0.376)	0.193** (0.0960)	0.190*** (0.0424)	0.0970 (0.0637)	0.0828 (0.119)
Rooftop or terrace	0.0577 (0.0850)	0.166*** (0.0454)	0.231*** (0.0527)	0.295*** (0.0976)	0.375*** (0.137)
Green areas or areas of common property	0.284 (0.408)	0.0281 (0.0895)	-0.155*** (0.0446)	0.0907 (0.0865)	-0.00465 (0.114)
<b>Nearby risk locations</b>					
Factories and industries	-0.315** (0.152)	0.0742 (0.0755)	0.0605 (0.0612)	-0.155 (0.117)	-0.169 (0.196)
Landfill	0.112 (0.162)	-0.257* (0.132)	-0.407** (0.199)	-0.0881 (0.123)	
Market places or slaughterhouses	-0.470** (0.225)	-0.0164 (0.109)	0.0230 (0.0650)	0.217 (0.172)	0.217 (0.372)
Airports	0.142 (0.197)	-0.111 (0.114)	0.00871 (0.0642)	0.102 (0.0944)	
Bus terminals	0.0474 (0.219)	0.0408 (0.124)	-0.0721 (0.0891)	-0.0141 (0.0902)	
Sewage Pipes	0.0721 (0.0735)	-0.101 (0.0674)	-0.0273 (0.0500)	-0.0350 (0.104)	-0.0587 (0.141)
Plant waste water treatment	0.204 (0.321)	-0.0409 (0.147)	-0.508** (0.200)		
Oil Transport	0.528*** (0.182)	0.0629 (0.155)	0.0715 (0.440)	-0.200 (0.140)	
High tension power	0.0483 (0.133)	0.169** (0.0812)	0.146* (0.0774)	-0.0476 (0.0952)	-0.610*** (0.213)
<b>Household Head's Characteristics</b>					
Gender	-0.135* (0.0736)	0.0696 (0.0609)	0.00442 (0.0551)	0.0208 (0.0965)	-0.316 (0.228)

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
<i>Marital Status (Cohabitation is omitted)</i>					
Married	0.205*** (0.0583)	0.143*** (0.0432)	0.104 (0.0652)	0.0226 (0.0811)	0.208 (0.141)
Widowed	-0.0658 (0.0949)	0.114 (0.0770)	0.0649 (0.0945)	0.161 (0.176)	0.394 (0.305)
Divorced	-0.0138 (0.104)	0.0656 (0.0692)	0.0987 (0.0890)	0.0184 (0.126)	-0.444 (0.341)
Single	-0.145 (0.125)	0.0985 (0.0740)	0.0231 (0.0832)	0.00221 (0.104)	-0.461* (0.255)
<i>Education (None/preschool is omitted)</i>					
Primary (1 - 5)	0.0119 (0.0651)	0.149** (0.0593)	0.131* (0.0741)	0.0956 (0.187)	
Secondary (6 - 13)	0.273*** (0.0837)	0.351*** (0.0688)	0.260*** (0.0872)	0.497*** (0.139)	-0.113 (0.318)
Tertiary (univ/technical)	0.240 (0.187)	0.565*** (0.0838)	0.466*** (0.0873)	0.536*** (0.136)	-0.113 (0.344)
Graduate	0.414 (0.294)	0.741*** (0.133)	0.522*** (0.103)	0.517*** (0.126)	0.0532 (0.343)
Age	0.00716*** (0.00193)	0.00716*** (0.00156)	0.0102*** (0.00205)	-0.000215 (0.00434)	-0.0124** (0.00512)
Observations	1884	3622	3307	1093	575
R-squared	0.529	0.470	0.303	0.230	0.471

Robust standard errors in parentheses

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

## 2. Hedonic Regression - Renters - 2003

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
Formal	-0.113 (0.0925)	0.120** (0.0563)	0.253** (0.1000)	-0.0234 (0.745)	1.876*** (0.325)
Urban	0.383*** (0.108)	0.283*** (0.0672)	0.793*** (0.245)	-0.293 (1.048)	
<b>Type Of Unit</b>					
Apartment	0.149* (0.0799)	-0.0228 (0.0377)	-0.0188 (0.0357)	-0.0422 (0.0675)	-0.387*** (0.0843)
Room(s) in tenancy	-0.125 (0.139)	-0.670*** (0.104)	-0.587*** (0.0939)		
Room(s) in other structure	0.107 (0.291)	-0.347*** (0.0818)	-0.584*** (0.139)	-0.839 (0.576)	-1.239*** (0.363)
<b>Wall Materials (bricks omitted)</b>					
Adobe	-0.630*** (0.223)	-0.345*** (0.0893)	0.168 (0.230)		
Wattle	0.169 (0.223)	-0.237** (0.103)	-0.0361 (0.159)		
Wattle and Daub	0.0342 (0.313)	-0.427** (0.174)	-0.168 (0.296)		
Coarse Wood	-0.267* (0.154)	-0.228** (0.112)	-0.110 (0.197)		
Prefabricated Material	-0.0388 (0.279)	-0.00794 (0.0979)	0.0544 (0.0891)	1.992** (0.782)	
Bamboo, Cane, Another Plant	-0.402*** (0.132)	-0.224** (0.0886)			
Zinc, Cloth, Cardboard, Disposable Materials	-0.818** (0.348)	-0.762** (0.307)			
<b>Floor Materials (Parquet, Marble omitted)</b>					
Carpet	0.244 (0.365)	0.131 (0.155)	0.117* (0.0674)	0.0869 (0.0772)	-0.0223 (0.106)
Vinyl, Tiles, Bricks	-0.157 (0.355)	-0.109 (0.122)	0.0159 (0.0565)	-0.00385 (0.0668)	-0.409*** (0.128)
Coarse Wood, Other Plant	-0.276 (0.380)	-0.161 (0.158)	-0.105 (0.0942)	-0.259 (0.196)	0.705 (0.498)
Cement	-0.458 (0.350)	-0.327*** (0.127)	-0.389*** (0.0831)	-0.291 (0.204)	-0.836*** (0.279)
Dirt	-0.405 (0.378)	-0.701*** (0.197)	-0.158 (0.230)		
<b>Type of Toilet (toilet connected to sewerage omitted)</b>					
Toilet connected to septic tank	0.392 (0.279)	-0.306 (0.288)	0.305*** (0.104)	-2.592*** (0.912)	
Disconnected toilet	0.919*** (0.323)	-0.153 (0.277)	-0.289 (0.258)		
Latrine	0.445 (0.365)	-0.623 (0.379)	-1.180*** (0.223)		
Low tide	0.703***	0.259			

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
No toilet	(0.226) -0.0554 (0.317)	(0.265) -0.866*** (0.325)	-0.158  (0.270)		
<b>Housing Utilities</b>					
Natural gas	0.160* (0.0957)	0.113*** (0.0403)	0.0658** (0.0319)	0.165*** (0.0607)	0.116** (0.0571)
Aqueduct	-0.101 (0.147)	0.0632 (0.0987)	-0.129 (0.168)	0.483 (0.424)	0.958** (0.369)
Sewerage	0.765*** (0.254)	-0.239 (0.281)	0.117 (0.173)		-1.002*** (0.165)
Rubbish collection	-0.0285 (0.132)	0.455*** (0.0785)	0.0831 (0.146)		
<b>Housing Amenities</b>					
Garden or courtyard	0.0109 (0.0824)	0.0313 (0.0348)	0.00768 (0.0333)	0.121 (0.0847)	-0.0657 (0.0754)
Lot or plot	-0.0395 (0.122)	-0.191*** (0.0563)	-0.0700 (0.0994)	0.320 (0.240)	0.173 (0.188)
Garage or parking place	0.664*** (0.231)	0.227*** (0.0710)	0.184*** (0.0459)	0.0898 (0.0621)	0.238*** (0.0742)
Rooftop or terrace	0.203** (0.101)	0.0404 (0.0425)	-0.0298 (0.0475)	0.250** (0.122)	-0.0310 (0.0904)
Green areas or areas of common property	-0.622 (0.703)	0.142** (0.0722)	-0.0168 (0.0510)	-0.0292 (0.0593)	0.0175 (0.0748)
<b>Nearby risk locations</b>					
Factories and industries	0.0405 (0.123)	0.0574 (0.0369)	0.164* (0.0904)	-0.169 (0.113)	-0.334*** (0.0979)
Landfill	0.0476 (0.162)	0.0854 (0.0586)	0.0260 (0.0690)	-0.0577 (0.115)	
Market places or slaughterhouses	0.0135 (0.179)	-0.0779 (0.0766)	-0.107* (0.0629)	-0.159 (0.137)	
Airports	0.182 (0.186)	0.0160 (0.0861)	-0.0855 (0.130)	0.0774 (0.0996)	
Bus terminals	0.0654 (0.0992)	-0.00670 (0.0621)	0.131 (0.0928)	-0.0172 (0.130)	-0.609** (0.270)
Sewage Pipes	-0.212* (0.109)	0.0242 (0.0507)	0.00705 (0.0451)	-0.0534 (0.106)	-0.0808 (0.105)
Plant waste water treatment	-0.460*** (0.150)	-0.420** (0.186)			
Oil Transport	-0.124 (0.220)	-0.0189 (0.261)	1.100*** (0.345)		
High tension power	0.240 (0.251)	0.0816 (0.112)	0.0151 (0.181)	0.198 (0.180)	-0.0977 (0.244)
<b>Household Head's Characteristics</b>					
Gender	-0.0461 (0.0930)	-0.0421 (0.0492)	-0.00508 (0.0386)	-0.0631 (0.0832)	-0.0182 (0.0695)
<i>Marital Status (Cohabitation is omitted)</i>					
Married	0.0649	0.0557	0.0771**	-0.0575	-0.0303

VARIABLES	<i>Stratum (market)</i>				
	(1)	(2)	(3)	(4)	(5 and 6)
	(0.0879)	(0.0374)	(0.0384)	(0.0710)	(0.0799)
Widowed	-0.0705	-0.164	0.0431	-0.0327	-0.143
	(0.179)	(0.103)	(0.0864)	(0.117)	(0.171)
Divorced	-0.0450	-0.0838	-0.0127	-0.139	-0.0702
	(0.107)	(0.0609)	(0.0489)	(0.131)	(0.0946)
Single	-0.0784	0.0428	-0.0142	-0.219**	-0.103
	(0.141)	(0.0610)	(0.0567)	(0.0872)	(0.0855)
<i>Education (None/preschool is omitted)</i>					
Primary (1 - 5)	0.119	0.164	0.208***	0.00671	
	(0.138)	(0.103)	(0.0759)	(0.308)	
Secondary (6 - 13)	0.226	0.314***	0.306***	0.0429	0.232*
	(0.144)	(0.105)	(0.0735)	(0.289)	(0.135)
Tertiary (univ/technical)	0.325**	0.452***	0.380***	0.205	0.230
	(0.164)	(0.110)	(0.0796)	(0.289)	(0.159)
Graduate	0.688	0.335	0.366***	0.228	0.352**
	(0.614)	(0.237)	(0.0893)	(0.289)	(0.156)
Age	0.0112***	0.00580***	0.00499***	0.00517**	0.00563*
	(0.00361)	(0.00143)	(0.00186)	(0.00219)	(0.00325)
Observations	562	2500	2754	556	276
R-squared	0.532	0.478	0.438	0.533	0.652

Robust standard errors in parentheses

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

### 3. Hedonic Regression - Owners - 2008

VARIABLES	<i>Stratum</i>				
	(1)	(2)	(3)	(4)	(5 & 6)
Formal	0.0420 (0.144)	0.0513 (0.305)	2.196** (0.861)		
Urban	-0.0876 (0.106)	0.00240 (0.166)	-0.00122 (0.266)	-2.156** (1.060)	0.348 (0.516)
# of Bedrooms	0.161*** (0.0252)	0.110*** (0.0335)	0.180*** (0.0397)	0.0807 (0.0855)	0.204*** (0.0576)
<b>Type of Unit (house is omitted)</b>					
Apartment	0.0627 (0.112)	0.211** (0.0939)	0.130 (0.134)	-0.502* (0.269)	-0.341** (0.165)
Room(s) in tenancy	0.0653 (0.267)	-0.0904 (0.762)			
Room(s) in other structure	0.741** (0.364)	-0.0250 (0.290)	0.992** (0.412)		
Other (tent, wagon, boat, shelter, bridge)	-0.366 (0.269)	0.704 (0.603)	0.385*** (0.143)		
<b>Wall Materials (bricks omitted)</b>					
Adobe	-0.379*** (0.120)	0.176 (0.154)	-1.186* (0.625)	-0.677 (1.237)	1.379*** (0.413)
Wattle	-0.186 (0.123)	-0.643*** (0.207)	-0.858* (0.454)		
Wattle and Daub	-0.624*** (0.109)	-0.733*** (0.213)	-0.475 (0.553)		
Coarse Wood	-0.478*** (0.114)	-0.521** (0.232)	-0.619 (0.550)		
Prefabricated Material	0.00941 (0.305)	0.413** (0.201)	-0.102 (0.472)		
Bamboo, Cane, Another Plant	0.0235 (0.232)	-0.270 (0.690)	-7.142*** (0.333)		
Zinc, Cloth, Cardboard, Disposable Materials	0.428 (0.311)	-0.132 (0.165)	0.649** (0.321)		
<b>Floor Materials (Parquet, Marble omitted)</b>					
Carpet	0.0824 (0.234)	-0.272 (0.683)	0.346 (0.498)	0.108 (0.464)	0.325 (0.494)
Vinyl, Tiles, Bricks	0.755 (0.527)	0.0542 (0.279)	-0.187 (0.638)	-0.202 (0.949)	0.176 (0.530)
Coarse Wood, Other Plant	0.601*** (0.131)	-0.322 (0.237)	-0.0789 (0.431)	-0.526 (0.586)	0.269 (0.419)
Cement	0.148 (0.133)	-0.579* (0.329)	0.702 (0.553)	-0.395 (0.875)	-0.588 (0.394)
Dirt	0.191* (0.103)	-0.491** (0.223)	-0.300 (0.501)	-1.018 (0.832)	
<b>Type of Toilet (toilet connected to sewerage omitted)</b>					
Toilet connected to septic tank	0.0516 (0.181)	-0.786 (0.628)	-0.0638 (0.367)	-1.738*** (0.473)	
Disconnected toilet	-0.0895 (0.185)	-0.620 (0.612)	-0.697 (0.433)		
Latrine	0.169 (0.269)	-1.200* (0.666)			
Low tide	-0.120 (0.294)	-1.818** (0.859)	1.432 (1.013)		

VARIABLES	<i>Stratum</i>				
	(1)	(2)	(3)	(4)	(5 & 6)
No toilet	-0.101 (0.197)	-1.166* (0.657)			
<b>Housing Utilities</b>					
Natural gas	-0.111 (0.0986)	-0.0988 (0.0897)	0.0446 (0.138)	0.126 (0.323)	0.0211 (0.282)
Aqueduct	-0.0402 (0.101)	-0.0377 (0.296)	0.541 (0.494)	-0.999 (1.084)	
Sewerage	0.0862 (0.169)	0.920 (0.623)	0.839** (0.360)		
Rubbish collection	0.116* (0.0622)	0.0805 (0.0532)	0.0917 (0.0723)	0.0635 (0.276)	0.274** (0.124)
<b>Nearby risk locations</b>					
Factories and industries, Market places or slaughterhouses	-0.0514 (0.180)	0.0324 (0.137)	0.162 (0.196)	0.351 (0.442)	0.523 (0.477)
Landfill	0.122 (0.133)	0.0337 (0.256)	-0.367* (0.206)	-0.594 (0.548)	-0.0756 (0.445)
Airports	0.507 (0.373)	-0.376* (0.203)	-0.150 (0.328)	0.253 (1.137)	
Bus terminals	-0.187 (0.219)	0.207 (0.266)	-0.270 (0.198)	0.925 (1.680)	
Sewage Pipes	0.0182 (0.102)	0.0372 (0.121)	0.155 (0.248)	-0.0965 (0.222)	0.817* (0.430)
Oil Transport	-0.167 (0.167)	-0.328* (0.197)	-0.106 (0.287)	-0.899 (0.855)	
High tension power	-0.117 (0.105)	0.311 (0.190)	0.373 (0.253)	0.213 (0.508)	0.158 (0.309)
<b>Household Head's Characteristics</b>					
Gender	-0.0965 (0.0772)	0.0225 (0.0914)	0.204* (0.110)	0.614* (0.351)	0.276 (0.207)
<i>Marital Status (Cohabitation is omitted)</i>					
Married	-0.00714 (0.0823)	0.191* (0.106)	-0.0135 (0.207)	0.181 (0.421)	0.262 (0.319)
Widowed	0.0306 (0.110)	0.118 (0.135)	0.116 (0.267)	0.308 (0.635)	1.034** (0.425)
Divorced	-0.170 (0.121)	0.169 (0.132)	-0.151 (0.254)	0.593 (0.724)	0.0756 (0.413)
Single	0.000837 (0.0969)	0.253** (0.115)	0.175 (0.206)	0.0434 (0.575)	0.330 (0.340)
<i>Education (None/preschool is omitted)</i>					
Primary (1 - 5)	0.210** (0.0907)	0.268* (0.159)	-0.191 (0.249)		
Secondary (6 - 13)	0.391*** (0.112)	0.344* (0.192)	-0.0394 (0.253)	-0.183 (0.304)	-0.650 (0.495)
Tertiary (univ/technical)	0.706*** (0.177)	0.426* (0.248)	-0.260 (0.272)	-0.0378 (0.215)	-0.555 (0.451)
Graduate	0.0962 (0.994)	0.785*** (0.228)	0.0976 (0.330)	0.00535 (0.462)	-0.550 (0.439)
Age	0.00453* (0.00268)	0.00221 (0.00343)	0.00154 (0.00520)	0.00858 (0.00805)	-0.00104 (0.00497)
Region Controls	Yes	Yes	Yes	Yes	Yes



VARIABLES	<i>Stratum</i>				
	(1)	(2)	(3)	(4)	(5 & 6)
Constant	14.83*** (1.054)	15.60*** (1.478)	12.94*** (1.778)	21.10*** (4.043)	14.18*** (3.325)
Observations	2408	2401	837	181	122
R-squared	0.261	0.115	0.151	0.190	0.408

Standard errors in parentheses.

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

## 4. Hedonic Regression - Renters – 2008

VARIABLES	<i>Stratum</i>				
	(1)	(2)	(3)	(4)	(5 & 6)
Formal	-0.0183 (0.117)	0.209 (0.177)	0.221 (0.302)		
Urban	0.0986 (0.0727)	0.146** (0.0567)	0.515*** (0.120)	0.891*** (0.257)	
# of Bedrooms	0.0685*** (0.0249)	0.110*** (0.0158)	0.119*** (0.0171)	0.109*** (0.0238)	0.146 (0.0968)
<b>Type of Unit (house is omitted)</b>					
Apartment	0.193*** (0.0531)	0.0765** (0.0303)	-0.0184 (0.0458)	0.0154 (0.105)	-0.279 (0.336)
Room(s) in tenancy	-0.243** (0.121)	-0.0360 (0.0771)	-0.359*** (0.105)		
Room(s) in other structure	-0.269 (0.182)	0.0105 (0.100)	-0.545*** (0.113)	-0.498** (0.202)	-0.480 (0.619)
Other (tent, wagon, boat, shelter, bridge)	0.918*** (0.280)	0.798*** (0.191)			
<b>Wall Materials (bricks omitted)</b>					
Adobe	-0.390*** (0.141)	-0.176 (0.152)	0.0135 (0.116)	-0.484 (0.352)	
Wattle	-0.280** (0.119)	-0.176 (0.108)	0.170 (0.546)		
Wattle and Daub	-0.00372 (0.197)	-0.266 (0.277)	-0.659*** (0.0952)		
Coarse Wood	-0.104 (0.131)	-0.00968 (0.163)	-0.169** (0.0836)	-0.511** (0.222)	
Prefabricated Material	0.342*** (0.113)	-0.141 (0.150)	-0.827*** (0.145)		
Bamboo, Cane, Another Plant	-0.420** (0.179)	0.660*** (0.158)	-0.264** (0.112)		
Zinc, Cloth, Cardboard, Disposable Materials	-1.020 (0.658)	-0.404 (0.284)			
<b>Floor Materials (Parquet, Marble omitted)</b>					
Carpet	0.584 (0.396)	0.309 (0.225)	-0.112 (0.157)	0.327 (0.216)	0.259 (0.468)
Vinyl, Tiles, Bricks	0.632** (0.311)	0.694*** (0.219)	-0.164 (0.238)	0.109 (0.214)	0.779* (0.395)
Coarse Wood, Other Plant	0.623*** (0.133)	0.495** (0.198)	-0.214** (0.0926)	0.00140 (0.120)	-0.108 (0.347)
Cement	0.349* (0.183)	0.170 (0.255)	-0.313** (0.125)	-0.159 (0.161)	
Dirt	0.317*** (0.121)	0.282 (0.198)	-0.373*** (0.117)	-0.602 (0.411)	
<b>Type of Toilet (toilet connected to sewerage omitted)</b>					
Toilet connected to septic tank	-0.0862 (0.239)	0.0344 (0.153)	-0.139 (0.221)	-1.043*** (0.313)	-1.855 (2.108)
Disconnected toilet	-0.183 (0.224)	0.238 (0.160)	-0.0142 (0.269)		
Latrine	-0.282 (0.241)	0.0650 (0.214)			
Low tide	-0.397	0.115			

VARIABLES	Stratum				
	(1)	(2)	(3)	(4)	(5 & 6)
No toilet	(0.269) -0.107 (0.254)	(0.188) 0.265 (0.348)		0.0106 (0.133)	
<b>Housing Utilities</b>					
Natural gas	-0.172*** (0.0573)	-0.160*** (0.0350)	-0.172*** (0.0406)	-0.0219 (0.0724)	-0.313 (0.288)
Aqueduct	-0.102 (0.0833)	0.0864 (0.153)	0.213 (0.135)	-0.324** (0.143)	2.336 (1.878)
Sewerage	-0.0145 (0.232)	-0.260 (0.164)	-0.0938 (0.251)	0.169 (0.285)	
Rubbish collection	0.0741* (0.0383)	0.0524** (0.0246)	0.0619*** (0.0163)	0.0742*** (0.0266)	-0.548 (0.390)
<b>Nearby risk locations</b>					
Factories and industries	0.0238 (0.0734)	-0.104** (0.0467)	-0.0232 (0.0513)	-0.0105 (0.126)	
Landfill	0.0690 (0.116)	0.172** (0.0701)	-0.150 (0.114)		
Airports	-0.0372 (0.137)	-0.113 (0.0849)	-0.000425 (0.172)	-0.0716 (0.107)	-0.304 (0.519)
Bus terminals	-0.376*** (0.125)	0.0598 (0.0508)	-0.206** (0.0806)	0.224* (0.120)	-4.164 (2.644)
Sewage Pipes	-0.0807 (0.0760)	0.0142 (0.0425)	-0.0735 (0.0561)	-0.174 (0.138)	
Oil Transport	-0.187 (0.155)	0.102 (0.119)	0.0734 (0.134)	-0.180 (0.192)	
High tension power	0.0944 (0.136)	0.0335 (0.0517)	0.122** (0.0535)	-0.0524 (0.123)	
<b>Household Head's Characteristics</b>					
Gender	-0.0342 (0.0573)	0.0164 (0.0443)	0.155*** (0.0512)	-0.000120 (0.104)	0.319 (0.295)
<i>Marital Status (Cohabitation is omitted)</i>					
Married	-0.0181 (0.0632)	0.0793** (0.0327)	-0.0419 (0.0529)	0.139 (0.114)	-0.121 (0.663)
Widowed	-0.115 (0.101)	0.0249 (0.0984)	0.114 (0.0888)	0.0458 (0.224)	0.761 (0.813)
Divorced	-0.0718 (0.0748)	-0.0625 (0.0570)	0.0137 (0.0632)	0.118 (0.149)	-0.290 (0.937)
Single	-0.192** (0.0766)	-0.0361 (0.0614)	-0.0191 (0.0628)	0.0913 (0.151)	0.0924 (0.894)
<i>Education (None/preschool is omitted)</i>					
Primary (1 - 5)	0.00717 (0.0890)	0.158* (0.0820)	0.127 (0.232)	-0.113 (0.304)	0.772 (0.653)
Secondary (6 - 13)	0.0690 (0.0913)	0.227*** (0.0807)	0.133 (0.235)	-0.128 (0.304)	
Tertiary (univ/technical)	0.242** (0.108)	0.295*** (0.0856)	0.264 (0.236)	0.0994 (0.306)	0.901* (0.466)
Graduate	0.385*** (0.139)	0.379*** (0.127)	0.390 (0.251)	0.149 (0.295)	1.185 (0.719)
Age	0.00366* (0.00207)	0.00159 (0.00127)	0.00261 (0.00172)	0.00336 (0.00269)	0.00798 (0.0109)
Region Controls	Yes	Yes	Yes	Yes	Yes
Constant	11.98***	10.53***	10.74***	12.15***	20.12***

VARIABLES	<i>Stratum</i>				
	(1)	(2)	(3)	(4)	(5 & 6)
	(0.664)	(0.550)	(0.686)	(0.865)	(4.528)
Observations	796	1441	715	123	35
R-squared	0.531	0.398	0.365	0.779	0.905

Standard errors in parentheses.

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