The Formal Determinants of Informal Settlements in Bogota, Colombia

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THE FORMAL DETERMINANTS OF INFORMAL SETTLEMENTS IN BOGOTA, COLOMBIA

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The central question in this dissertation is why formal mechanisms of housing production and land allocation have been unable to absorb the growing demand in the cities of the developing world. My general methodological approach is to analyze the historical process of urbanization of Bogotá, Colombia a city known by the prevalence of informality and its rich experience in the implementation of different land and housing policies. My hypothesis is that informal settlements are structural to the formal process of production of the built environment because, within a context of inequality and natural property rights, this process tends to under-provide land with urban services. The dissertation is structured as three interrelated papers. In the first paper, I study the relationship between an institutional context dominated by the concept of property as a natural right and the pattern of under-provision of urban services arguing that informality is engendered in the same formal process of production and allocation of the built environment because the concept of property as a natural right produces a dynamic of privatization of benefits of city growth and socialization of its costs that results in under-provision of urban services. In the second paper, I study the causes of the pattern of under-provision using a political economy and a stakeholder approach. I explain the paradox of why urban services are under-provided when they can increase land values by more than their cost by describing how this pattern is compatible with the incentives of the stakeholders involved in the production and consumption of the urban space. In the third paper, I represent the

articulation between the formal and informal mechanisms of housing production using a simulation model based on System Dynamics. Using the model I show how informality arises from the inadequacy of a system of infrastructure financing based on tariffs and cross-subsidization and from the unintended consequences of the traditional interventions to deal with the problem such as up-grading and public housing. I also propose and test a policy based on eliminating the interventions that are incentivizing informality and shifting the source of financing infrastructure from cross-subsidies to property taxation.

BIOGRAPHICAL SKETCH

Andres G Blanco was born in Bogotá, Colombia. He received his Bachelor degree in Economics in 1999 and his Master of Science in Regional Development Planning in 2005 from the *Universidad de los Andes* in Bogotá. Between 1999 and 2006 he worked as a researcher and consultant in different projects involving local governance and urban development for organizations like the Lincoln Institute of Land Policy, the United Nations Development Program, the Departments of Finance and Government in Bogotá, and the *Universidad de los Andes*. He also worked as a bank manager in an industrial district in his home town. In 2006 he started his doctoral studies in Cornell University under the guidance of Drs. Mildred Warner, Charles F. Nicholson, and Mary Roldán. Currently, he is an Assistant Professor in the University of Florida, where he teaches courses and conducts research about the economic aspects of planning in areas like housing, land use, and economic development.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1. THE QUESTION

We live in a 'planet of slums' (Davis, 2006). According to Acioly (2007) one third of urban citizens are living in overcrowded and inadequate settlements across the world. That is nearly 1 billion people. This 'big bang' of urban poverty is far from over: if the current trend continues the slum population could be between 1.5 to 2 billion people in 2020, although "no one knows whether such gigantic concentrations of poverty are biologically or ecologically sustainable" (Davis, 2006: 6).

Within this trend, the fastest growing type of slums is informal settlements: self-constructed housing lacking property titles, planning, infrastructure, and social services.[1] In spite of the traditional debate about the convenience of this kind of development (slums of hope or slums of despair), informality produces many negative outcomes: substandard housing, inefficient land use patterns, expensive curative policies, spatial segregation, urban sprawl, discontinuous growth, destruction of peasant communities, environmental problems, and urbanization of zones of high risk.

[1] These settlements have also been called 'Illegal' (Fernandes, 1997), 'Spontaneous' (Jaramillo, 1999) and 'Self-help' (Gilbert, 1998). I have decided to use the concept of 'informality' over 'illegality' because although these settlements do not comply with legal and technical requirements, their magnitude, incidence and persistence have given them some grade of social legitimacy. I have also avoided the concept of 'Spontaneous' because informal settlements do not arise from one day to the next; instead, they follow a long process of consolidation involving different stages: they start with a basic shelter that is developed progressively for several years through self-construction; later, these consolidated informal settlements are subdivided and extended according to the household composition; finally, if these accommodations have not been demolished, they might be formalized through public policies of titling and up-grading. I have not used the concept 'Self-help Settlements' either, because it excludes the growing informal rental market and the secondary real estate transactions that begin after the consolidation of informal settlements.

Informal settlements are a ubiquitous part of the urban landscape in the developing world. In Latin America, for instance, between 25 percent and 60 percent of the population of the main cities was housed in this kind of development by the 1990s (Gilbert, 1998). Nowadays, however, informal settlements are no longer a particularity of the Third World, Ward (2003) indicates that there are some 1,600 informal settlements (*colonias*) near the Mexican border in Texas, housing more than 350,000 working class residents.

The central research question guiding this dissertation is why formal mechanisms of housing production and land allocation have been unable to absorb the growing demand in the cities of the developing world. The objective is to contribute to a growing body of literature about the causes of informal settlements that has been more focused on the demand side of the problem, that is, on why there is a demand for informal housing, than on the supply side of the question, that is, why formal alternatives are scarce, inadequate, and unaffordable.

As I describe in more depth in the next chapter, the literature on informal settlements suggests several determinants of housing informality that can be classified in four groups: macro-structural conditions, micro-motives, market based explanations, and the failure and unintended consequences of public policies. **Macro-structural** conditions include factors associated with the peripheral process of capitalist development like demographic boom, explosion of urban-to-rural migrations, and inequality. **Micro-motives** encompass theories that describe informal settlements as 'architecture that works': a rational alternative for the poor that sustains survival strategies like transforming labor into capital through the process of self-construction, adapting physical spaces to generate extra income, and accessing social networks through the participation in the collective struggle for settlement consolidation.

Market based explanations include factors like the high costs of formal land, the high profitability of informality for its promoters, and affordability for those demanding this type of accommodation. **Failure and unintended consequences of public interventions** explain why policies designed to deal with informal settlements like migration controls and public housing in the 50s-60s, up-grading and technical assistance in the 70s-80s, and titling and demand subsidies in the 90s were ineffective and, in some cases, produced new incentives for informalization.

In this dissertation, I combine some of these factors examining the causes for the inability of formal alternatives to absorb the growing demand for low-income housing as the key determinant of informal settlements. The dissertation is based on the case of Bogotá, Colombia a city known for the historic prevalence of informal real estate markets and a rich experience in the implementation of different interventions to deal with informality. Bogotá is an interesting case study of informality, because rather than arising through invasion and squatting, its informal settlements are the product of 'pirate subdivisions': illegal parcelings of peripheral land sold by the legal owners without planning permission and without basic infrastructure to poor people who build their own houses through the process of self-construction (Doebele, 1977), a pattern that is becoming more common throughout the developing world.

My hypothesis is that informal settlements are structural to the formal process of production and allocation of the built environment because, within a context of income inequality and natural property rights, this process tends inherently to under-provide land with urban services preventing the consolidation of formal alternatives of low-income housing. The reason for this is that the concept of property as a natural right has prevented the consolidation of a system of financing urban services through the valorization that they produce. In this context, property taxation has been replaced by

a system of cross-subsidization through tariffs that is not able to provide enough infrastructure due to the unequal distribution of income characteristic of Bogotá. This under-provision of serviced land is reinforced by a strong tendency of speculation and the unintended consequences of expensive policies such as public housing and up-grading.

My general methodological approach is historical since the rise and persistence of informal settlements is a long term process in which the macro-estructural, micro-motives, market-based, and public policy determinants are combined within specific political, economic, and institutional frameworks. The historical study is conducted using a combination of quantitative and qualitative methods as I will describe in the next section.

1.2. THE WORK PLAN

The dissertation is structured as three interrelated papers, all oriented by the same general question and hypothesis, but each one approaching specific elements of the question from a different degree of abstraction, theoretical background, and methodological perspective. The dissertation also includes additional elements to facilitate the articulation of the papers and provide a description of the context of the case study and the literature about informality.

The next chapter, titled “Determinants of Informal Settlements: the Literature about the Latin American Case” includes a brief review of the literature of informal settlements categorizing the explanations of the phenomenon in the four groups described above: macro-estructural, micro-motives, market, and public policies. This chapter shows that the literature of informal settlements suggests several determinants

for the rise and persistence of this phenomenon that, in general, are focused on the demand side of the question. This provides a justification for the central question of this dissertation about why formal alternatives could not absorb the growing demand and why they are scarce, inadequate, and unaffordable.

The third chapter contains the first paper titled "Logics of Allocation of the Built Environment and Natural Property Rights: Land Entrepreneurialism and Informal Settlements in Bogotá, Colombia". In this paper, I study the relationship between formality and informality by analyzing the institutional framework that enables the rise and persistence of informal settlements. To that end, I build a dialogue between planning theories and the historical process of urbanization in Bogotá to argue that informality is engendered and embedded in the same formal process of production and allocation of the built environment. The reason is that the concept of property as a natural right predetermines the results of the logics that govern the allocation of the built environment (market, rational-comprehensive, participation, and resistance) producing a dynamic of privatization of the benefits of city growth and socialization of its costs. This dynamic, which can be called 'land entrepreneurialism', results in under-provision of land with urban services making formal alternatives unable to absorb the growing demand for housing in the city.

The fourth chapter includes the second paper titled "No-growth Machines: Why Urban Services are Underprovided in Bogotá, Colombia". Here, I study in more depth the context of governance in the city that has produced the system of production and allocation of the built environment described in the first paper by analyzing the paradox of why urban services are under-provided when they can increase land values by much more than their cost. To that end, I conduct an historical analysis of the process of urbanization of Bogotá to argue that the scarcity of infrastructure is

structural to the process of production of the built environment because this scarcity is compatible with the incentives of the stakeholders involved in the production and consumption of the urban space. As part of the argument, I explain how the pattern of under-provision of urban services has been the result of a system of financing urban growth based on tariffs and cross-subsidization and how this system has produced an outcome that is collectively inefficient but nevertheless apparently 'rational' from an individual perspective. Finally, I discuss the political economy implications of the argument analyzing the possibilities for change.

The fifth chapter includes the third paper titled "Why Formal Housing Alternatives in Developing Countries are Insufficient, Inadequate, and Unaffordable. A Model of the Process of Production of the Built Environment in Bogotá, Colombia". In this paper, I represent the articulation between the formal and informal mechanisms of housing production using a simulation model based on System Dynamics. The model shows how informality arises from the inadequacy of a system of infrastructure financing based on cross-subsidization and from the unintended consequences of the traditional interventions to deal with the problem such as up-grading and public housing. Using the model, I estimate the future behavior of informality in the city showing that despite the current decrease in the population growth rates, informal settlements will grow faster in the future if nothing is done to prevent it. I also test a policy based on eliminating the interventions that are incentivizing informality and shifting the source of financing of urban services from cross-subsidies to property taxation. Finally, I discuss how this policy could be a more effective way to solve the negative consequences related to informal settlements.

The sixth chapter includes the conclusions where I summarize the key results of the papers and discuss potential implications of the study for planning theory and practice.

In addition, I include an appendix with the technical details of the model used in the fifth chapter describing the process of operationalization and the sources of information used.

In short, and simplifying, the next chapter describes the literature on informality giving a justification for the question. The third chapter analyzes the relationship between an institutional context dominated by the concept of property as a natural right and the pattern of under-provision of urban services using planning theory. The fourth chapter studies the causes of the pattern of under-provision using a political economy and a stakeholder approach. The fifth chapter represents the articulation of the formal and informal mechanisms of housing provision using simulation modeling. The sixth chapter presents conclusions and implications. As a whole, these papers support the hypothesis that informal settlements are structural to the formal process of production of the built environment because, within a context of income inequality and natural property rights, this process is structurally unable to produce enough land with urban services to absorb the demand by formal means.

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CHAPTER 2

DETERMINANTS OF INFORMAL SETTLEMENTS: THE LITERATURE ABOUT THE LATIN AMERICAN CASE

Latin America is the most urbanized developing region of the world. The percentage of urban population in Latin America is not only higher than in other regions, 75.3 percent in 2000 compared to 37.9 percent in Africa and 36.7 percent Asia, but also has increased more rapidly particularly at the middle of the 20th century. Latin American urban population increased from 25 percent in 1925 to 61.2 percent in 1975, compared to a growth from 8 percent to 25.2 percent in Africa and a growth from 9.5 percent to 24.7 percent in Asia in the same period (Cerrutti and Bertoncello, 2003).

For this reason there is a large and growing body of literature studying different aspects of Latin American urbanization. Many of these studies analyze informal settlements proposing different explanations for the causes of the rise and persistence of this phenomenon. In this section, I will review this literature presenting its basic ideas about the determinants of informality using the same classification introduced before: macro-structural conditions, micro-motives, market based explanations, and the failure and unintended consequences of public policies.

2.1. MACRO-STRUCTURAL CONDITIONS

These explanations are based on structural factors like strong demographic growth and high rural-to-urban migration, poverty, cultural legacy, and 'weak' states. Because of their nature these explanations are not always explicit in the literature but they are

important to understand the common perception of the phenomenon and the cognitive frameworks that have produced some of the policies to deal with informality.

Explanations about demographic booms argue that informal settlements are caused by the explosion of housing needs driven by the high rate of urbanization, through natural growth and migration, which is common at initial stages of development. The classical theoretical proposition about the link between development and urbanization is Lewis' 'Dual Sector Model' which shows that people migrate from a traditional agricultural rural sector to a modern industrial urban sector because the first is characterized by lower productivity and lower wages in relation to the second (Guha-Khasnobis, Kanbur and Ostrom, 2006). Because these propositions are centered on the demand side of the problem, they cannot explain why formal mechanisms could not absorb the growing demand, an essential question since informal settlements can persist even when the population is not growing. In a context of scarcity of serviced land, regulations of minimum densities for high- and middle-income housing will displace low-income families from the formal city producing new informal settlements (Smolka, 2002).

The explanations related to poverty argue that because most of these new migrants are poor they are unable to convert their potential demand for housing into effective demand. This factor, however, cannot explain the phenomenon by itself, because, although spatial correlations between poverty and housing informality are evident in the majority of cities, not every poor person is an informal settler and not every informal settler is poor. Smolka (2002) shows that the percentage of informal units in some Latin American cities reaches 70 percent while the average percentage of families below the poverty line is 27 percent. In the same way, the strong growth in the number of informal settlers has been accompanied by a relative stability in poverty

indicators. Moreover, the perception that low housing quality means low costs is a myth. For example, the average price in Latin America of an unserviced lot of 72 square meters in the informal market is nearly US$2,000, or US$27 per square meter, which is very high compared to the average minimum monthly wage in the region of US$130 (Smolka, 2002). For that reason, the poorest are accommodated in the rental markets of the city center and, increasingly, in rental markets in informal settlements (Doebele, 1977; Gilbert, 1981; Vernez, 1974). Finally, it is worth noting that informal settlements are not only for low-income groups. Fernandes (1997) and Caldeira (1999) describe how the rural outskirts of the main Brazilian cities have been urbanized by unauthorized fortified enclaves for high income groups. Currently this trend is growing across Latin America (Jaramillo, 1999).

The explanations related to a cultural legacy argue that there is a tendency to 'urbanistic indiscipline' that incentivizes poor people to break planning laws and regulations. This explanation has been criticized in many ways. Doebele (1977) argues that the participants in the process of informal housing want to become a part of the system rather than to oppose it, finding that informal settlers in Bogotá, Colombia not only know very well the legal framework but also use it to defend their tenure. In fact, he characterizes informal settlers as 'politically conservative' because they are hostile to new invasions near their settlements for fears of losing public spaces and the possibility of regularization.

Moreover, many informal settlers pay property taxes in spite of the informality of their tenure as a way to assure the passage of property to their heirs and as a way to increase the chances of formalization (Doebele, 1977; Fernandes, 1997). For these reasons, in her classical work about 'the myth of marginality', Perlman describes how Brazilian 'squatters' "descended from their hillsides and marched alongside businessmen and

housewives in support of law and order, tradition, family, and private property" (Perlman, 1976: xvi).

The explanations based on the 'weakness' of the state argued that the main cause of informal settlements is the inability of municipalities to control urban development. Such ideas, nevertheless, seem to be incapable to explain the complexity of the phenomenon since even countries with strong states and central planned economies have experienced informal urbanization. Song (2007) describes how the massive rural-to-urban migrations in China are producing 'urbanizing villages' characterized by cheap, unplanned, overcrowded, and substandard self-built housing developed in collectively owned rural land that has been absorbed by the growing Chinese cities.

Moreover, these structural factors as a whole fail to explain what causes the diversity of patterns of informality across cities and periods. Despite the visual similarity of the phenomenon across cities caused by the techniques of self-construction (Jaramillo, 1999), it varies according to the particular form of land possession in a wide range of 'degrees of illegality' (Fernandes, 1997). In general, the most important types are 'squatting' or invasion, pirate subdivisions and secondary informal markets.

Invasion is the collective or individual illegal appropriation of public or private land mostly in areas near the city center or in difficult terrain. They were more common in the middle decades of the 20th century and characteristic of cities like Lima, Peru and Valencia, Venezuela (Gilbert, 1981). Invasions have benefited less from regularization programs because their 'informality' is not only because of the lack of services or planning permits but also because of the lack of property titles; this is why there are some non-regularized invasions or *favelas* in Brazil that are more than 100 years old (Fernandes, 1997).

Pirate subdivisions are individual lots created in peripheral land without city permission. These illegal subdivisions are sold by the legal owner and are not authorized for urbanization. In most cities the number of pirate subdivisions increased in the last decades of the 20th century but they also have been a historic characteristic in cities like Bogotá and Mexico City (Gilbert, 1981). In this case, the 'informality' arises from the fact that the subdivisions, the provision of basic infrastructure, and the housing construction have not been approved. Their informality also arises from the fact that the lots lack urban services either partially or completely.

Secondary informal markets are the informal transactions that arise in the process of consolidation of 'squatting' or 'pirate' settlements. Secondary informal markets include real estate (sell-buy) transactions and other strategies like subdividing individual plots, renting rooms, and sharing spaces. Because of the exhaustion of urban land, these markets are becoming more active producing a pattern of densification of the periphery[2] (Smolka, 2002).

2.2. MICRO-MOTIVES

This group includes factors that explain why low-income households choose informal housing even when formal alternatives are available. Research on this topic, mostly case studies, has shown that location decisions of poor families in cities of developing countries are not based on the factors expected in the neoclassical models such as area or distance to work opportunities in the Central Business District (CBD), rather, empirical work on informal settlements throughout Latin America has shown that there are no strong correlations between residence and work place (Abramo, 2003)

[2] For descriptions of this phenomenon see Kowarick and Ant (1994) for the case of Sao Paulo, Jaramillo (1994) for the case of Bogotá, and Miraftab (1997) for the case of Mexico City.

because most poor are self-employed and employment opportunities are unstable (Vernez, 1974). Thus, locational decisions of poor families are based on the benefits of informality and the structure of the household.

Informal settlements have also been characterized as 'architecture that works' (Turner, 1976) because they are compatible with the needs of the poor (Turner, 1976). For instance, Abramo (2007) argues that 'urbanistic freedom' is a benefit of informality because it permits the expansion of the accommodations as the family grows (Gilbert, 1999). In addition, informal settlements enable households to generate extra incomes by renting rooms or using them for commercial activities. Moreover, informal settlements allow the opportunity of accessing social networks and reciprocity economies (Abramo, 2007; Friedman, 1992). Through these networks, low income households can minimize monetary costs through labor pooling and the production of goods for communal consumption.

Nevertheless, informal settlements, even when the land occupation has been achieved through invasion, require capital and extra labor force for the process of self-construction. That is why young and single people prefer formal rented rooms near the city center.[3] Households headed by women also prefer rented rooms because they want to minimize commuting distances to spend more time with their children (Miraftab, 1997).

New migrants tend to occupy rented rooms in the city center for a period while they accumulate enough capital to acquire informal land and to start the process of incremental construction. However, the exhaustion of the housing supply in the city

[3] The Colombian term is *inquilinatos:* rooms "rented by a family in an apartment or house occupied by another family, or a room, apartment, or house shared by more than one family" (Vernez, 1974: 422). They are also known as *vecindades* in Mexico, *conventillos* in Bolivia, Chile, Argentina and Uruguay *callejones* in Peru or *mesones* in Salvador (Gilbert, 1998: 79).

center and the competition from middle income groups and from commercial and office activities have increased the rents in the traditional tenements and redirected the rental demand to informal settlements: In his analysis of Bogotá, Vernez (1974) finds that more than 2/3s of the newly arrived migrants moved to rental housing units in pirate areas where they wait for a period of 4 to 10 years to acquire their own informal subdivision. The growing demand for informal rental units plus the depletion of urbanized land have increased the prices of new informal settlements, making it even more difficult for the poorest families to become owners (Gilbert, 1999).

2.3. MARKET BASED EXPLANATIONS

The basic notion of the explanations related to market mechanisms is that informal settlements exist because formal prices are extremely expensive (Smolka, 2002), because pirate mechanisms are very profitable for their promoters but also are affordable and convenient for low income families (Doebele, 1977; Gilbert, 1981; Vernez, 1974) and because the positive externalities of formalization turn informal settlements into opportunities for capital gains and speculation (Abramo, 2003).

In terms of the first explanation, Smolka (2003) shows that the price of a square meter of serviced land in the periphery of Latin American cities can go from US$32 to US$172. Therefore, a household above the poverty line would need up to 15 years saving 20 percent of its monthly wages to buy a plot of 150 square meters.

In terms of the high profitability for its promoters, Doebele (1977), argues that since the 'pirate subdivider'[4] role is limited to buy large areas of cheap peripheral raw land

[4] The Latin American term is *urbanizador pirata* but as Doebele points out that term is "too grand to use for persons who typically only lay out dirt roads, stake off lots, and install an occasional water spigot". (Doebele, 1977: 536).

from its original owners,[5] establish a basic street pattern and sell individual illegal subdivisions giving some kind of 'soft' title to the buyer like a receipt or a 'promise of purchase and sale',[6] the costs of the operation are minimal and the profits are considerable. Moreover, to maximize his profits the pirate subdivider makes promises about future infrastructure and in many cases he himself organizes social mobilizations demanding services from the municipality (Rocha et al 2006). Also, the pirate subdivider sells the first lots for a low price, or gives them out for free, in order to incentivize demand (Fernandes, 1997).

As for the incentives for informal settlers produced by the potential valorization caused by regularization programs, Abramo (2003) states that the positive externalities derived from the expansion of the formal city (expansion of basic infrastructure and public facilities) increase the value of informal settlements converting them into 'locational capital'. In this way, through the sell-buy transactions of consolidated informal housing the poor can realize capital gains and be beneficiaries of speculation.

Another cause for the high price of formal land are the regulations of density like Floor-Area Ratios (FAR), regulations of growth like Urban Growth Boundaries (UGB) and cost-increasing regulations like administrative procedures and infrastructure requirements. Although a perfect causality between regulation and price cannot be established, Smolka (2003) has argued that the problem is the combination of sub-regulation in low-income settlements and an elitist over-regulation in high income areas to reinforce spatial segregation. This has constrained the supply and increased the demand for formal land, increasing the final cost of formal housing and pushing low-income demand to the informal sector (Smolka, 2003).

[5] Because the original landowners are threatened by invasions their market power is weak. So, the pirate subdivider can appropriate the rent caused by the expected new use of the land: informal subdivisions.
[6] The Latin American term is *promesa de compraventa* which is a document that specifies the obligations of the seller and the buyer.

2.4. FAILURE AND UNINTENDED CONSEQUENCES OF PUBLIC INTERVENTIONS

The fourth group of explanations studies the failure of several governmental actions to prevent informal settlements and the analysis of the unintended consequences of formalization efforts. In this section, I present these explanations using a chronological approach to highlight the contextual and theoretical frameworks from which governmental actions can be understood. This is especially important for public policies related to informal settlements because they depend on social constructions not only of the housing problem but also of broader issues like the relationship between private and collective property rights and the relationship between planning and markets (Fernandes, 1997; Ward, 2003).

I define four periods of public policies according to four social understandings of informal settlements. First, from the 1950s to the 1960s, the period of 'prohibition and discouragement' with preventive policies like control of rural-to-urban migration, demolition of informal settlements and provision of public housing. Second, from the 1970s to the 1980s, the period of 'acceptance and encouragement' with curative policies like minimum requirements, technical assistance and up-grading. Third, in the 1990s, the period of 'market friendly responses' with curative policies like titling and preventive policies like subsidies. Finally, in the 2000s, the period of 'progressive planning' with preventive policies to increase formal housing provision.

This does not mean that public policies dealing with informal settlements can be understood like a perfect succession of competing paradigms. Most of these policies have coexisted even when they are antagonistic and usually have been reformulated and justified from diverse ideologies. Indeed, the majority of Latin American Cities

continue implementing all these policies in different degrees thanks to the fact that the public agencies responsible for them have persisted even as the theoretical frameworks that support the policies have been revaluated.

1950s and 1960s: prohibition and discouragement

By 1925 few Latin American Cities had informal settlements; by 1950 between 10 percent and 20 percent of the urban population lived in informal housing; by 1975 this percentage reached more than 50 percent in most cases (Gilbert, 1998). In these years the percentage of urban population in the region grew from 25 percent in 1925 to 41.4 percent in 1950 to 61.2 percent in 1975, configuring one of the most rapid and spectacular migration processes in human history.[7]

Because of this massive migration, the first public reaction was to prohibit informal settlements and discourage migration. Informality was viewed as social pollution caused by the irrational decision of rural migrants leaving the countryside. For this reason, public policies in the 1950s and 1960s focused on three objectives: prevent rural-to-urban migration, prohibit and demolish informal settlements, and provide public housing.

Migration policies were not effective. Programs of promotion of growth poles as a way to redirect migration to secondary cities were incompatible with the necessity of creating big consumption centers in the context of the Import Substitution Industrialization (ISI) strategy. More important, these policies failed because they did not acknowledge the migrant's rationality of decision-making; the decision of whether, where and when to migrate depends on the availability of social networks

[7] Urban percentages in Latin America are only comparable with those of the developed world: 40.1 percent in 1925, 54.9 percent in 1950 and 70 percent in 1975. However, the increase in the rate of urbanization in Latin America is nearly two times more rapid than the increase in the rate of urbanization Europe and North America (Cerrutti and Bertoncello, 2003).

and not on the simple calculation of economic opportunities. This produces a sort of 'scale economies of migration' in the main urban centers that had received more population in the past creating a reinforcing incentive for migration: in this way, "actual migration flows may be perpetuated long after their economic rationale has disappeared" (Vernez, 1974: 427).

The denying of services in the biggest cities and the demolition of informal settlements did not solve the problem either because local governments were unable to prevent the displaced settlers from creating new informal settlements. As for public housing, despite the allocation of considerable proportions of public resources to this policy, it could not keep up with the pace of urban growth. Moreover, many public units were occupied by middle income groups and public officials.

1970s and 1980s: acceptance and encouragement

After decades of failed preventive policies, informal settlements began to be accepted as a valve for social discontent. One important factor for that was the popularization of the theories of self-help housing as 'architecture that works' described above. But other considerations of political and economic convenience were also important: politicians realized that immigrants were also voters and that the social mobilizations in informal settlements for public services were a source of patronage and clientelism (Gilbert, 1998). City officials thought that informal settlements were housing policy on the cheap (it is leveraged by private resources) that provided high-density housing and that matched the preferences of the poor (Ward, 2003). In this way, the social construction of informal settlements changed from being a "form of social cancer" (Gilbert, 1999: 96) to be a "viable and rational housing alternative" (Vernez, 1974: 426).

The new objectives were: encourage the poor to build their own houses through technical assistance, incentivize the pirate subdividers to provide lots with minimal infrastructure in the formal market through the establishment of lower requirements for urbanization, and provide services a posteriori through up-grading programs. The results of these policies, which still have an important role in urban planning today, are a matter of debate. Much has been done in terms of infrastructure to improve living conditions in urban settlements but, at the same time, these policies have provided incentives for new informal settlements and represent a high fiscal burden for the municipalities.

Programs of technical assistance have been criticized because they cannot solve structural problems of informal settlers like the lack of public services and the location in risky areas. Simplified regulations for low income housing not only have not encouraged pirate subdividers to comply with minimum urban requirements but also have been an incentive to formal developers to lower their standards, thus, replicating patterns of informal settlements. This has resulted in neighborhoods with insufficient public spaces and deficient public services. Very often the scarce infrastructure of neighborhoods with minimum requirements has to be replaced by the municipalities[8] (Rocha et al, 2006).

Up-grading programs also have been a matter of controversy. First, they are more expensive than a planned urbanization due to the inversion of the technical sequence of urban development: planning, servicing, and building (Ward, 2003). According to

[8] Paradoxically, the problem seems to be that these minimum requirements were extremely minimal for a formal development but at the same time they were more than the pirate subdivider could provide. According to Doebele (1977) the simplified norms in Bogotá by 1972 established: "(1) that penetration roads have a stabilized base (i.e. not necessarily paved), and that other roads only be laid out and visible; (2) that community water spigots, one for every four blocks, were sufficient if their water had been tested by the Secretary of Health; (3) that street lighting by posts was required (4) that a public telephone be available no more than one kilometer from the community; (5) that each lot have a latrine" (Doebele, 1977: 547).

Aristizabal and Ortiz (2002) the cost of up-grading an informal settlement per square meter in Bogotá is 2.7 times the cost of a square meter in a planned and served area. Second, they increase the prices of pirate parcels and the profits of illegal subdivision since the pirate subdividers include the expectation of valorization for services in their prices (Abramo, 2007). Third, in contrast to new informal subdivisions, informal consolidated settlements (those that have been already built through self-construction) have not been valorized after up-grading programs (Abramo, 2007) since these settlements are not attractive to the general market due to their poor location and their identification with marginality[9] (Smolka, 2003; Ward, 2003).

1990s: market friendly responses

At the end of the 1970s and during the 1980s the political and academic left started to criticize the policy of acceptance and encouragement because it was considered a capitalists' mechanism to assure the reproduction of labor without paying proper wages (Doebele, 1977; Gilbert, 1998; Fernandes, 1997). From this view, informal settlements were considered a system in which the society gained through the exploitation of the poor since the pirate mechanism reduced the risk of invasion for land owners saving the 'sanctity' of private property, provided an implicit subsidy not only to commercial and industrial firms but also to the general public through cheap domestic labor, allowed the exercise of clientelism and patronage by politicians, and permitted governments to avoid the implementation of real social housing policies (Gilbert, 1981).

[9] This has an important corollary: up-grading programs are not causing gentrification. The reason for this is that the turn-over dynamics of the secondary real estate market tend to decrease with the degree of consolidation of informal settlement. Smolka (2002) points out that the few examples of "colonization" of up-graded consolidated informal settlements by middle income groups are due to the pauperization of the middle class that followed the neoliberal policies of the 1990s and are not caused by the increased valorization of real estate markets in these areas.

These critiques obliged governments to implement new policies with 'social content' within the framework of budget deficits and neoliberal reforms. In this context, governments embraced the titling policies proposed by de Soto (1989) as a magical formula of social policy without the conflicts of redistribution of wealth[10] (Calderon, 2002). According to de Soto (1989), informal settlements were caused by excessive regulations of property rights that were constraining the capabilities of the poor to solve their own problems. In this way, legal titles were supposed not only to solve the housing question but also to alleviate poverty by unleashing the entrepreneurialism of the poor.

The expected outcomes of these policies of 'regularization by decree' have also been the focus of controversy. The most important critiques can be summarized as follows. Titling does not provide security against eviction because this security depends on the degree of consolidation of the informal settlement and the form of land acquisition (Ward, 2003). Titling is not likely to enable informal settlers to gain capital benefits through rising property values because informal settlements are not attractive to higher segments of the demand (Gilbert, 2001). This policy is not likely to improve the dynamics of the real estate market because title transference means higher transaction costs (Gilbert, 1999). Legal titles do not increase the probability of public servicing and basic infrastructure because utility companies have different criteria to define the expansion of the networks, in particular commercial considerations (Ward, 2003). Title does not mean more access to credit because banks' policies privilege regular income over collateral to reduce the risk of default (Calderon, 2002) and because the pirate subdivider is himself a source of credit (Gilbert, 2001). Title is not a condition

[10] The most active policies of titling have been pursued in Peru and Mexico. Calderon (2002) describes that between 1996 and 2000 1,134,000 legal titles were granted in Peru most of them in major cities: 645,165 in Lima, 112,631 in Arequipa and 74,180 in Trujillo.

to home improvement and consolidation as the process of incremental construction has shown over the years (Ward, 2003).

Apart from titling, the other privileged policies were subsidies and other demand side interventions in accordance with the new ideological influence of the World Bank's 'enabling markets to work'. The basic idea was to supplement the income of the poor to improve the demand for formal social housing, creating an incentive to the private sector to generate more formal provision. Demand subsidies have been criticized not only because they tend to benefit middle-income groups due to the impossibility of the poorest to get mortgage loans but also because, within the context of insufficient supply of serviced land, they increase land values configuring a transference of public resources to landowners (Rocha et al, 2006).

2000s: progressive planning

During the 1990s new factors of change emerged: decentralization process, democratization of local politics, growing scarcity of land, faster rises in land values and decreasing support of the poor to traditional partisan politicians. These forces plus the verification of the negative outcomes of informal settlements encouraged new debates and new proposals in housing policy (Fernandes, 1997; Gilbert, 1999; Rocha et al, 2006).

A first group of these new proposals is centered in particular aspects of the phenomenon. Some have proposed that curative policies must be universal as a way to avoid the dynamics caused by the unequal treatment of the localized neoliberal policies: valuation/devaluation (Abramo, 2003), segregation (Ward, 2003), and gender

bias[11] (Miraftab, 1997). Others have proposed that titling policies must grant collective titles to the community rather than individual titles (Gravois, 2005). Still, others have tried to replicate parts of the policy of minimum requirements implemented in the 1970s with the provision of lots with basic infrastructure to be developed through incremental self-construction (Rocha et al, 2006).

Another group has been focused on the critique of cognitive and ideological frameworks of housing policies, the dependence on ownership and the 'sanctity' of acquired rights. The idea that ownership is the best way of occupation is based on the notion of the civilizatory power of private property and has been expressed through the absence of any rental policy and a bias in the regulations against landlords[12] (Jaramillo and Ibanez, 2002). This produces low supply of accommodations for the formal rental market limiting the alternatives for the poor and increasing the costs of transaction in real estate markets. In the end, a weak rental market causes low residential mobility and high commuting costs (Gilbert, 1999).

The 'sanctity' of acquired rights refers to the traditional character of land as a private property with complete rights and no social duties. Fernandes (1997), describing the Brazilian case, states that property rights have been the very pillar of housing policy defining different reactions of the state according to the 'degree of illegality': 1) Lowering taxes and providing infrastructure for free in formal areas. 2) Tolerating pirate settlements (but delaying provision of services). 3) Negating rights and services

[11] Miraftab (1997) shows that non-economic variables (such as age and gender) are important in the logic of informal markets. Households headed by young women prefer formal alternatives near the city center because they want to minimize commuting times (allowing more time with the children) and because self-construction requires activities more commonly associated with males. This has an important corollary: the feminization of the labor force in Latin America that followed the neoliberal policies of the 1990s can be a factor explaining the growth of informal rental markets.

[12] For example, in Colombia the rent amount cannot exceed 1 percent of the market value of the property, the landlord cannot ask for security or damage deposits and the tenant has legal advantages in case of conflict (Jaramillo and Ibanez, 2002).

to invasions.[13] These new proposals support the idea that a radical change in the operation of land markets is needed to solve the problem of informal settlements (Gilbert, 1981; Vernez, 1974).

This change starts by recognizing the social character of private property and ends in the implementation of effective measures to push-back social costs to land owners and developers in order to mitigate the speculation with land, the profits of the pirate subdivider, and the fiscal burden. Governments are controlling the negative outcomes of mal-functioning land markets by: creating differential property taxes for empty spaces, freezing land prices to the level prior to the announcement of urbanization projects or changes in land uses, implementing land banks, charging infrastructure costs to landowners, and recovering land value increments caused by public actions.

2.5. CONCLUSIONS

The literature of informal settlements suggests several determinants for the rise and persistence of this phenomenon. Most of this work is focused on the demand side of the question. The explanations related to 'macro-structural conditions' are centered in the demographic transformations that cause the growing demand for low-income housing in the cities. In terms of what I have called 'micro-motives', the arguments are oriented to understand why informal housing is compatible with the characteristics of the demand. As for the 'market-based' accounts the discussion is focused on the affordability of informality for its users, although they include some supply considerations in terms of the analysis of the high costs of formal land. Finally, most

[13] In Brazil, as well as in other Latin American countries, property rights in invasions have been recognized only after public compensation, at market prices, to the legal owner or through *usucapiao* or 'adverse possession' after the uncontested permanence in the informal settlement for more than 20 years (Fernandes, 1997)

of the explanations about the failure and unintended consequences of public interventions are directed to understand the responses of the demand side to different policy regimes.

In this sense, the explanations described in this chapter are more related to the question about why the demand for informal settlements exists than to the question about why the formal alternatives could not absorb this demand. In the next chapters I present three papers focused on the second question trying to understand why formal alternatives are scarce, inadequate, and unaffordable.

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CHAPTER 3

LOGICS OF ALLOCATION OF THE BUILT ENVIRONMENT AND NATURAL PROPERTY RIGHTS: LAND ENTREPRENEURIALISM AND INFORMAL SETTLEMENTS IN BOGOTÁ, COLOMBIA[14]

ABSTRACT

In planning theory, four logics frame collective decisions about the built environment: market, rational-comprehensive, participation, and resistance. Ideally, these logics should function as a system of checks and balances in which each one limits the potential failings of the others. The case of Bogotá, Colombia shows that instead of balancing each other, these logics collude into 'land entrepreneurialism', a dynamic that privatizes the benefits of city growth and socializes its costs creating a pattern of scarcity of urban services and incentivizing informal settlements. In this framework, informality is a system of co-optation that neutralizes the resistance of the poor through 'pirate subdivisions' which are, in fact, 'the privatization of squatting'. Because land entrepreneurialism is engendered in the institution of property as a natural right and the power relations that it produces, addressing informality entails more than its 'formalization'. It entails the creation of a new type of formality based on a broader notion of property rights.

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3.1. INTRODUCTION

'Bogotá is sexy' was the city's promotional slogan when it started its transformation in the early 1990s.[15] For scholars studying the city it seems to be, given the remarkable improvement in the quality of life for its citizens. In fact, Bogotá has been declared by international institutions and scholars a 'model of good urban governance' (Gilbert, 2006). For instance, real public investment per capita in the city has increased by more than 650 percent (SHD, 2007). Local revenues increased from 2 percent of the GDP in 1990 to more than 4.6 percent in 2006 (SHD, 2007). More than 4,000 hectares of informal settlements, twice the figure for the previous fifty years, have been legalized (SDP, 2007). Public service delivery has reached almost 100 percent of legalized neighborhoods (Gilbert, 2006). Unsatisfied Basic Needs declined from 17.2 percent in 1993 to 9.2 in 2005 (DANE, 2009). Violent deaths per 100,000 inhabitants fell from more than 80 in 1993 to 23 in 2005 (Gilbert, 2006). Additionally, an international recognized Bus Rapid Transit system mobilizing more than 1.5 million passengers per day for less than 10 percent of the cost of a heavy rail system has been successfully implemented (*Transmilenio,* 2009), commuting times have decreased by 32 percent, and average speeds in the city have increased by 25 percent (UNDP, 2008). Because of these changes a sense of civic pride has been discovered by Bogotá's residents, a relatively new sentiment in a city mainly populated by migrants and their descendants (Gilbert, 2006).

But planners also have been interested in this city of more than 7 million because of the historic prevalence of informal land and housing markets (Gilbert, 2000, 1999). Rather than by invasion and squatting, Bogotá's informal settlements are the product of 'pirate subdivisions': illegal parcelings of peripheral land sold by the legal owner

[15] The actual slogan in Spanish was: *Bogotá Coqueta.*

without planning permission and without basic infrastructure to poor people who build their own houses through the process of self-construction (Doebele, 1977). Indeed, the term 'pirate urbanization'[16] is a Colombian invention and it has been studied in Bogotá since the 1970s when the World Bank (Mohan, 1994) and scholars like Vernez (1974) and Doebele (1977) started to analyze the phenomenon.

In this paper, I study the implications of the pirate subdivision system for the theories that frame collective decisions about resource allocation. To that end, I first identify and describe four logics of collective decision making about the built environment in planning theory: market, rational-comprehensive, participation, and resistance. Ideally, these logics should function as a system of checks and balances in which each one limits the potential failings of the others. Within this framework, informality usually is seen as part of the resistance logic in which access to the built environment for poor and excluded people is achieved by 'insurgent urbanism' and legitimized by the 'right to survive'. Analyzing Bogotá's process of urbanization through these logics, I argue that instead of balancing each other they collude into a dynamic of privatization of the benefits of city growth and socialization of its costs. Within this dynamic, which can be called 'land entrepreneurialism', informality is not part of the resistance logic but a system of co-optation that prevents social struggle by neutralizing the potential resistance of the poor through the pirate subdivision system.

I, then, analyze the causes of land entrepreneurialism arguing that it is engendered by the institutional notion of property rights and the power relations that it produces. Property rights act as an 'operative constraint' to the each logic (market, rational-comprehensive, participation, and resistance) because each seeks to define the best

[16] Although, the Colombian term is 'pirate urbanization' I have decided to use the more specific notion of 'pirate subdivision' because as Doebele (1977) puts it the term 'pirate urbanizer' is "too grand to use for persons who typically only lay out dirt roads, stake off lots, and install an occasional water spigot" (Doebele, 1977: 536).

social use for a privately owned commodity. This is what Foglesong (1986) calls the basic contradiction of planning in a capitalist democracy: capitalism engenders planning as a form of state intervention because it is unable to meet the consumption needs of the working class and provide the public utilities used as a means of production. At the same time, capitalism constrains planning as a method of policy formulation because the institution of private property prevents social control over scarce resources.

In Colombia, despite many attempts at reform, private property has been conceived as a natural right according to the notion of property in the Napoleonic Civil Code of 1804: an almost absolute privilege to use, enjoy, and 'abuse' a 'material thing'. Defending their property as a natural 'acquired right', Colombian landed classes have blocked any attempt of redistribution, instead transferring the cost of solving the social conflict to the public domain. In rural areas, agrarian reform has been limited to colonization of public lands generating an endless cycle of migration-colonization-conflict-migration that is still feeding civil conflict in the country. In most cities this pattern has been reproduced through municipalities allowing and even encouraging the invasion of public lands. But in Bogotá, because most lands are privately owned, property has been protected and open expressions of social conflict have been avoided through pirate subdivisions. With this system, owners sell their land illegally realizing considerable profits, while the cost of servicing these lands falls on the general public through expensive up-grading programs.

Finally, I discuss the concept of natural property rights and its implications for planning theory arguing that despite some current theoretical and political discourses that celebrate natural property rights as a historical inevitability that sustains liberty, justice, and free markets, property is a social construct with various dimensions that

are not included in the narrow concept of natural property rights. As Krueckeberg (1995) argues, property is not a univocal concept defining the relation between a person and a thing, but rather the relation between persons in regard to that thing. In this sense, addressing informality entails much more than its 'formalization'; it entails the creation of a new type of 'formality' based on a broader notion of property that includes not only the rights of the owner but also his or her responsibility to take into account the rights of the community.

3.2. FOUR IDEAL LOGICS OF COLLECTIVE DECISION ABOUT THE BUILT ENVIRONMENT

In this section, I describe the ideal system of checks and balances among the logics of collective decision-making about the built environment: market, rational-comprehensive, participation, and resistance. Under the market logic, which is usually regarded as the most efficient, access to the built environment is defined by exchange values through pricing mechanisms. Within this logic, individuals guided by their interests and budget restrictions achieve a unique, stable, and efficient social order that aligns current purchasing power and preferences. This powerful concept has been justified using neoclassical models of spatial economics that propose an 'urban invisible hand' (Abramo, 2006) by combining a Walrasian representation of citizens as utility-maximizing agents with a Von-Thunenian representation of the space as a trade-off between area (quantity of land to be consumed) and distance (commuting time to work opportunities in the Central Business District). However, because land is not transportable, the built environment is particularly subject to one of the most prominent market failures: externalities. Moreover, the market logic disregards distributional issues, because it only assures access to the built environment for the

ones that are 'willing and able' to pay, leaving aside the ones that are 'willing but not able'.

For these reasons, the market logic should be complemented with some kind of central coordination. This justifies the rational-comprehensive logic, which can be defined as a centralized method of policy formulation that identifies social objectives and selects the most effective action through means-end analysis (Lindblom, 1959). Under this logic, access to the built environment is defined by a hierarchical definition of actions through intellectual problem-solving analysis according to public-good ideals. This 'replacement of the discipline of the market by the discipline of the expert' (Foglesong, 1986) has been criticized because of the impossibility of taking into account every relevant factor of a social problem in a scientific method of analysis (Lindblom, 1959), the authoritarianism of masking the spontaneous order in a planning utopia where 'the right to have plans belongs only to the planners in charge' (Jacobs, 1961), the difficulty in defining a single 'common interest' (Davidoff, 1965), and the commutative relationship between power and rationality (Flyvberg, 2003).

The participation logic tries to overcome these limitations defining access to the built environment by social consensus through the deliberation of active citizens. This logic has been regarded as a more democratic process of decision making than the rational-comprehensive logic by two planning theories: advocacy planning and deliberative planning. Advocacy planning proposes a pluralist process of political contention in which the planner should function as an advocate of minorities (Davidoff, 1965), with the objective of counteracting the power of majorities in representative democracies (see the median voter theorem[17]). Deliberative planning seeks to create public arenas

[17] "Politicians might generally be said to seek to maximize votes. In an efficient liberal democracy this means aligning themselves with the preferences of the median voter – the class of voter capable of tipping political power by transferring allegiance to the nearest centrist party" (Webster and Lai, 2003: 172).

of ‘inclusionary argumentation’ (Healey, 1996) to ‘speak the unspeakable’ (Sandercock, 2003) allowing the definition and transformation of identities (Frug, 1999), the framing of political agendas, and the creation of trust by exposing the self to the ‘otherness’ (Forester, 1999). The objective is to counteract the difficulties of aggregating individual preferences in a democratic way (see Arrow’s impossibility theorem[18]) by shaping personal tastes and values in a way that transcends selfish interests and promotes collective welfare (Sandercock, 2003).

However, in most cases decision making through deliberation is not possible because aggregating preferences depends on their measurability and comparability (Sager, 2002) and because empowering minorities can make reaching consensus difficult (Baum, 1994). Moreover, because ‘the power of words depends on the power of the speakers’ (Fainstein, 2000), assuming that the planner is a neutral mediator between interests is not only naive but also reproduces the legitimization of power through planning (Warner, 2008).

Hence, real inclusion demands complementing ‘invited’ spaces of participation with ‘invented’ spaces of political action (Miraftab and Wills, 2005), that is, complementing the participation logic with the resistance logic. Under this logic, access to the built environment is defined by the right to survive through ‘insurgent urbanism’ according to the need to get minimum standards of living (Holston, 2009; Miraftab, 2009). The idea of the resistance logic as a way of creating opportunities not otherwise available is usually related to the concept of informality, which is generally associated with using illegal means to achieve legal ends (Portes and Castells, 1989). In this view, informality is seen as an extra-legal sphere (Hart, 2006; Lomnitz and

[18] “There is no set of rules that will produce a unique social ranking of alternative resource allocations consistent with the rankings of individual members of society” (Webster and Lai, 2003: 132).

Diaz, 1993; de Soto, 1989) that is defined in opposition to the market, rational-comprehensive, and participation logics (Roy, 2009).

3.3. THE FOUR LOGICS IN BOGOTÁ, COLOMBIA

In this section, I describe how the four logics are materialized in the context of Bogotá. To that end, I use an historical analysis of the process of urban development in the city drawing information from primary sources (such as urban plans, laws, policy documents, public budgets, and cadastral bases) and secondary sources (such as academic work and newspaper articles) with the objective of analyzing the distance between the ideal logics and their real results.

The market logic

The result of the market logic in Bogotá has been a socially fragmented space where poor households experience higher densities (238 persons per hectare compared to 99.5 persons per hectare in high-income areas), longer commuting times, and inadequate infrastructure (Rincón, 2006; Jaramillo, 1999; Amato, 1969). High-income neighborhoods have been located in the northern part of the city since the 1930s when the elites abandoned the city center looking for more functional and modern accommodations (Amato, 1968). These areas are characterized by low-density developments, adequate infrastructure, and high land values.

The middle-class has been accommodated at higher densities near the rich, functioning as a 'buffer' between high- and low-income groups. The demand for low-income housing could not be absorbed by the depreciated stock left by the middle class for reasons that will be explained in the next section. Instead, this demand was directed to

the periphery, especially to the south and west, through pirate subdivisions. More than 7,000 hectares in the city, representing 25 percent of the total area of Bogotá, have an informal origin, which means they were urbanized with no infrastructure, public spaces, social services, property titles, or planning permissions.

Figure 3.1 shows the socioeconomic residential strata in the city. Since 1983, the Planning Department (SDP) divides the housing stock in 6 strata according to the quality of units and neighborhoods. Strata 1 to 3, considered low-income housing, are concentrated in the south, west and the periphery. Strata 4 to 6, considered middle- and high-income housing are concentrated in non-peripheral areas to the north-east.[19]

Because of the concentration of urban services, land values in the north are much higher. The ratio of the value of a square meter of land in a northern residential neighborhood to the value in a southern neighborhood can reach 20:1. For commercial uses the ratio can reach 27:1 (LONJA, 2005). However, because of the general deficit of land with urban services, land values have increased at a high pace in every segment of demand and in every area of the city. Between 1960 and 2005 real land prices have increased at a geometric annual rate of 4.84 percent in high-income areas, 8.04 percent in middle-income areas in the north, and 3.70 percent in low-income peripheral areas (LONJA, 2005). This has meant falling lot sizes, during the 1970s and 1980s, plot sizes decreased from 155 square meters to 73 square meters for formal sites and from 131 square meters to 75 square meters for informal sites (Gilbert, 1996). Currently, the minimum legal lot for low-income housing is 35 square meters.

[19] Note the stratum 6 residential areas in the extreme north outside the limit of Bogotá's census area. Some of these areas can be considered high-income informal settlements since they are located in natural preservation areas and most do not have planning permissions (*El Tiempo*, 2008).

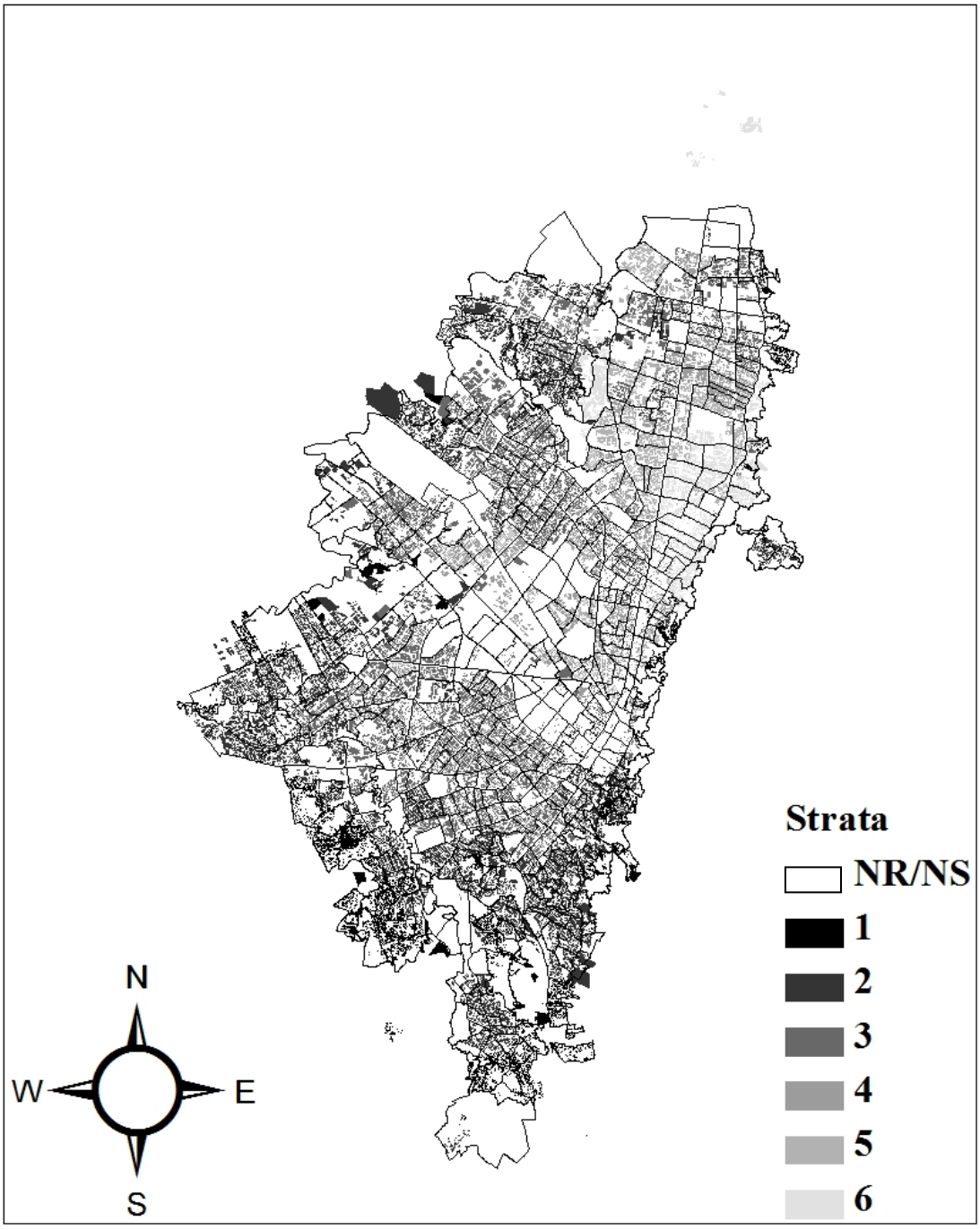

Figure 3.1 Socioeconomic Residential Strata in Bogotá:
Strata 1 to 3 are considered low-income housing, stratum 4 is middle-income, and strata 5 to 6 are high-income. NR/NS means Not Residential or Not Stratified.
Data source: DANE (2006), UAECD (2006). Author's own elaboration

Under-supply of land with infrastructure and high land values have reinforced each other through a strong tendency of withholding land with urban services from the market. In 2008, the Cadastral Department classified more than 5,255 hectares, almost 16 percent of the total urban area in Bogotá, as 'urbanized but not built' (UAECD, 2008). From this total at least 1,035 hectares, divided in 1,187 lots, were classified by the Planning Department as 'fattening lots' (vacant lots being held off the market for purely speculative purposes). It has been calculated that some 100,920 low-income housing units could be built on these lots (SDP, 2009).

The rational-comprehensive logic

Instead of balancing the failures of the market logic, the rational-comprehensive logic has reinforced them. Zoning regulations and Floor Area Ratios (FAR) have protected high-income areas from the competition of the poor: although high-income neighborhoods in the north were protected by high land prices (Gilbert, 1996), middle- and low-income groups could compete for these areas through densification, taking advantage of the preference of the wealthy for large lots. This market dynamic, was displacing the rich and increasing commuting times (Amato, 1969). But comprehensive plans since 1944 have mandated low densities for high-income neighborhoods in the north, medium densities for middle-class neighborhoods, and high densities for poor neighborhoods in the south and west (Rincón, 2006). Indeed, the initial zoning plans for the city defined special areas in the south for workers' neighborhoods (*barrios obreros*) and explicitly prohibited rooming houses in the north (Rincón, 2006; Jaramillo, 1999; Saldarriaga, 1996).

In terms of planning standards, these comprehensive plans have usually defined higher requirements of infrastructure for high-density areas. This has meant higher costs and

'impossible standards' for formal development of low-income housing. A reform in planning standards in 1972 allowed the possibility of 'minimum requirements' in the south. Thanks to this reform, a considerable number of low-income housing units was constructed and the rate of informalization actually decreased. However, the policy faced many challenges because this change was not accompanied by an increase in the land zoned for high-density. Also, the scarcity of zoned land resulted in high land values and most 'minimum requirements' areas were occupied by middle-income households. Moreover, there was considerable social opposition because relaxing planning standards was considered a 'legitimization of slums' (Mohan, 1994; Molina, 1990; Gilbert and Ward, 1982).

Urban growth boundaries have been used with the objective of slowing the physical expansion of the city. The urban perimeter has not been very successful and it has been updated periodically because informal settlements continue to be developed outside the legal boundaries. Moreover, the urban perimeter has not been articulated with the provision of services since public utilities in Bogotá have considerable independence from the Planning Department both in terms of policy definition and budget allocation (del Castillo, 2003; Roda, 2000; Mohan, 1994). According to Gilbert and Ward (1982: 108) the urban perimeter has only been important "insofar as it has limited the availability of serviceable land and thereby increased the price of land within the perimeter and lowered the price beyond".

The costs of urban services and infrastructure have been traditionally assumed by the local government and its agencies. Trunk service provision, usually called general burdens, including roads, electricity, water, and sewer networks, has not been charged to developers although some administrative mechanisms have been partially implemented mandating the allocation of land for roads and public parks since 1902

(del Castillo, 2003). Urban services have been funded primarily through user charges and debt, and public utilities have traditionally maintained a commercial orientation (Gilbert, 2007, 2006, 1990; Mohan, 1994; Gilbert and Ward, 1982).

The benefits produced by the provision of urban services have not been recovered through property taxes. According to a study conducted by the World Bank, in 1972 property taxes in Bogotá accounted only for 13.7 percent of total expenditures compared to an average of 42.8 percent for other 25 third world cities studied (Mohan, 1994). In 1970 the revenue from property taxes was 0.67 percent of the city's Gross Regional Product (a measure of the size of the economy), by 1980 the proportion had fallen to 0.39 percent and by 1990 it was 0.34 percent (my own calculation using data from DNP [2009] and SDP [2000]). By way of comparison, Smolka (2003) estimates that property taxes usually represent between 3 to 4 percent of the Gross Regional Product in North American cities, that is almost 10 times the revenue in Bogotá. In general, property tax revenue in Latin America has been very low. According to Uribe and Bejarano (2008), revenues from this tax represent only 0.37 percent of the region's GDP whereas in OECD countries this proportion could reach up to 2.12 percent. For these reasons, during the 1970s and 1980s property tax revenue actually decreased in real terms failing to keep up with the pace of inflation. The weakness of property taxation in Bogotá is exemplified by the fact that during the second half of the 20th century the tax on beer consumption generated more revenue than the property tax (SDP, 2000). One important consideration, however, is that the property tax was designed progressively and most low-quality units have not been subject to taxation.

An important funding mechanism in the city has been the valorization fee which is a form of special assessment or betterment charge introduced in Colombia in 1925. The valorization fee allowed municipalities to finance infrastructure improvements in

built-up areas by charging the cost to beneficiaries according to spatial proximity (Maldonado, 1999). According to Smolka and Amborski (2000), 16 percent of all local public expenditures in Bogotá were financed through this mechanism in 1968. By 1996 the proportion had fallen to 6.6 percent. However, it is important to highlight that the valorization fee is not a redistributive mechanism since it is based on proximity. For that reason, it reinforced the concentration of infrastructure in formal areas (Maldonado, 2006; Mohan, 1994).

The participation logic

Although 'invited' spaces of citizenship have a long tradition in Colombia thanks to the influence of the ideas of informal settlements as 'architecture that works' popularized by scholars like John Turner (1976) and implemented on a large scale by the Alliance for Progress in the 1960s, community participation has been conceived more as a way to legitimize the status quo than a real alternative for public decision-making. Institutionalized community participation was introduced in Colombia in 1958 by the National Front, a political deal between the two main elitist parties that sought to restore civilian government after a period of military dictatorship and violence.

The main institutional arrangement for community participation in Colombia has been the Community Action Committee (*Junta de Acción Comunal*, or JAC) a mechanism implemented through national decree in 1959. JACs are neighborhood associations elected by affiliated members whose committee size is determined by the degree of unsatisfied basic needs in the community (Lulle, 2005). Initially, they were more common in rural areas since JACs were intended as a mechanism to pacify the country in the context of a period of civil war in Colombia known as *La Violencia* which left

two hundred thousand dead and over two million Colombians displaced between 1948 and 1966 (Roldán, 2002; Alfonso et al, 1997). During the 1960s urban JACs were consolidated as a way to exchange views with city planners about public service demands and the development of small projects of micro-planning (Gilbert and Ward, 1985).

From the beginning JACs institutionalized a vertical form of communication between a centralized national government and the communities. JACs came to be criticized for promoting practices of clientelism and patronage as funds were channeled from the National Ministry of the Interior and parliamentary grants (*auxilios parlamentarios*) to communities according to partisan criteria (Mohan, 1994; Alfonso et al, 1997). For instance, presidents of the JACs were granted special powers such as the distribution of subsidized kerosene and food (Gilbert, 1998). Thus, formal spaces of participation have been limited to the institutionalization of demands for public services replacing the conflict over land with clientelist negotiations over services.

The resistance logic

'Insurgent urbanism' has also reinforced this pattern. A survey in 1972 indicated that only 0.7 percent of Bogotá's housing was the product of invasion processes (Gilbert, 1981). In general, squatting has not been permitted in the city and the few successful cases took place in public lands or in lands with little exchange value. Nevertheless, even in those invasions the state had to compensate the legal owners. Peattie (1982) describes two cases of invasions in Bogotá: in the first, the land belonged to a charitable foundation; in the second, the land belonged to a hospital. Both cases were organized by the communist organization Provivienda after "the word got around that the lands had no owner" (Peattie, 1982: 28).

Everett (1999) describes another case where the 'invasion' was allowed initially because the area was steep and had no access roads; however, three decades later titleholders reclaimed their property because land prices rose due to the construction of one major avenue near the invasion. Unprecedented violence was used to evict the residents and social riots erupted. In one episode:

> "early in the morning on the day set for the eviction, tanks lined the avenue below the barrio. Inside the barrio hundreds of heavily armed police stood watch, monitoring the residents' calls from the neighborhood's one phone. Mounted police rode through the hills above the barrio. Helicopters flew overhead. In all, approximately 1,000 police troops had arrived for the eviction of 30 families" (Everett, 1999: 19).

In the end, most squatters were evicted and land in the most profitable areas was returned to the titleholder.

In contrast, pirate subdivisions, although illegal, have been permitted and even encouraged by the municipality. With this system the poor are co-opted and the conflict for land between landowners and poor households is replaced by the conflict for services between poor residents and the municipalities (Jaramillo, 1994). Thus, the majority of social mobilizations have not been motivated for land but for basic services and most have been organized by the same pirate subdivider (Rocha et al, 2006). For instance, in the 1970s and 1980s, there were more than 300 urban protests in Colombia (128 in Bogotá), 80 percent were motivated by the lack of basic public services and none was motivated by land issues (Maldonado, 2000). Even taking these mobilizations into account, social protests have been rare in comparison with other cities and have not led to general strikes (Gilbert, 1990; Ocampo et al, 1994).

Usually pirate subdividers use these social manifestations as leverage to engage in politics; for example, between 1992 and 1995, Bogotá's councilman Mariano Porras sold more than 7,000 informal lots in exchange for money, communitarian work and 10 votes (per lot) for his campaign to Congress. Today, he is a fugitive sentenced to 84 months in prison.

3.4. THE COLLUSION OF THE FOUR LOGICS: LAND ENTREPRENEURIALISM

In sum, the four logics of collective decision making about the built environment are not balancing each other but colluding into a different dynamic in which landowners are able to internalize the positive externalities produced by city growth and externalize the costs to the public realm. This dynamic, that can be called 'land entrepreneurialism' following the evocative term that LeGrand (1986) used to describe Colombian rural landed classes, produces scarcity of land with urban services, substandard housing, inefficient land use patterns, expensive curative policies, spatial segregation, urban sprawl, discontinuous growth, destruction of peasant communities, environmental problems, and urbanization of zones of high risk.

Land entrepreneurialism configures a specific form of what Harvey (2005) calls 'accumulation by dispossession'. Land entrepreneurialism is not a purely economic process of transactions between equals but is a political process of predation of the urban commons. Its outcomes are not the efficiency of free-markets, the rationality of comprehensive planning, the deliberation of participation, or the empowerment of resistance but, rather, a distorted amalgam of the logics governed by the ability of landowners and developers to win privileges at the expense of the community. The

result of land entrepreneurialism is an oligopolistic market protected by planning regulations and legitimized through participation that prevents resistance by co-opting the poor through the pirate subdivision system.

The collusion of the four ideal logics has predetermined the results of the main policies of affordable housing (public housing, up-grading of informal settlements, and demand subsidies), turning them into an instrument to reinforce land entrepreneurialism. Because policies of public housing have not been accompanied by policies to control land prices, the state has been obliged to build low-income housing with high densities at long distances from the city center. For this reason, public projects are considered "official slums: tiny concrete cells built on small plots, miles from the centre of town" (Gilbert, 1998: 97), while the best located public units are expensive and are occupied by medium-income groups through middle-class 'poaching'. Thus, despite the allocation of considerable public resources, public housing has not satisfied the needs of the poor. In his account of Bogotá, Doebele (1977) finds that at the peak of public housing construction, the 1970s, after huge investments made with the support of the Alliance for Progress, public accommodations housed only 5.7 percent of the families in the lower income quintile and 7.1 percent in the low-middle quintile.

Up-grading is more expensive than a planned urbanization due to the inversion of the technical sequence of urban development: planning, servicing, and building (Ward, 2003). According to Aristizabal and Gomez (2002), the cost of up-grading an informal settlement per square meter in Bogotá is 2.7 times the cost of a square meter in a planned and serviced area. Moreover, up-grading increases prices of pirate parcels and the profits of illegal subdivision because the expectations of valorization for services are included in the prices of the informal market (Abramo, 2003).

Demand-side interventions have been designed as a way to supplement the income of the poor to improve the demand for formal social housing creating an incentive to the private sector to generate more formal provision. But because the land market is controlled by land entrepreneurs within a context of an insufficient supply of land with basic services, subsidies have increased land values and configured a transference of public resources to landowners (Rocha et al, 2006).

3.5. DETERMINANTS OF LAND ENTREPRENEURIALISM: NATURAL PROPERTY RIGHTS

Land entrepreneurialism and the pirate subdivision system are engendered in the specific form of land tenure. In Bogotá most lands have been privately owned because of the high agricultural productivity of the land surrounding the city. Until the 1930s and since colonial times the city was dense and its 150.000 inhabitants were concentrated around the center according to the Spanish urban design defined by the Laws of the Indies. This changed in the 1940s through the interaction of three factors: the economic crisis of the 1930s that forced agricultural landowners to sell the lands surrounding the city, the explosion of rural-to-urban migration that almost doubled the population every ten years, and the implementation of mass transportation systems (Jaramillo, 1994, 1980). Because peripheral land was acquired by land entrepreneurs so early,[20] they were able to define the urbanization process, reducing the market, rational-comprehensive, participation, and resistance logics to land entrepreneurialism.

The key determinant of land entrepreneurialism in Bogotá has been the Colombian notion of property rights. During the 19th century, the notion of property rights in the

[20] High concentrations of peripheral land have been a constant characteristic in Bogotá. In 1985, 70 percent of the land surrounding the city was owned by 1 percent of the owners (Robledo, 1985: 56).

Colombian Civil Code, as well as in the various constitutions, was influenced by the Napoleonic Civil Code of 1804 and the French Declaration of the Rights of Man and of the Citizen of 1789.

The Napoleonic Civil Code, derived from Roman law, defined property as a natural right, an almost absolute privilege over a material thing, limited only by legal decision under the condition of compensation at market prices, that grants the rights of *usus*, *fructus, et abusus*: the rights to use, to enjoy, and to abuse. The XVII article of the French Declaration of the Rights of Man and of the Citizen stated that "since property is an inviolable and sacred right, no one shall be deprived thereof except where public necessity, legally determined, shall clearly demand it, and then only on condition that the owner shall have been previously and equitably indemnified" (HRCR, 2010).

This natural notion of property rights predetermines the four ideal logics of land allocation, giving landowners the power to retain land thanks to the *usus* right (if they have the right to use, they also have the right to not use), the power to internalize the positive externalities of city growth thanks to the *fructus* right (if they have the right to enjoy the product of their land, they also have right over its value increase even when that value is produced by the community), and the power to externalize to the society the costs of the use of land thanks to the *abusus* right (if they have the right to use their property as they choose, they do not have to pay for the negative effects that this use could generate for the society) (Maldonado, 2003). Because of these reasons, urban development governed by civil codes has been characterized as laissez faire urbanism (Fernandes and Maldonado, 2009)

The notion of natural property rights explains why the pirate subdivision system is functional to land entrepreneurialism. The reason is that this system respects the

'sanctity' of private property because the poor have to buy the land (Gilbert, 1981). That is why Davis (2006) characterizes the pirate subdivision process as the 'privatization of squatting'. It also explains why invasions are more likely in cities with extensive public lands and gives a clue to understand why the pirate subdivision system is displacing squatting as the main form of informal urbanization. Well-defined land natural property rights incentivize landowners to supply their lands illegally to reduce the risk of invasion.

In this way, the case of Bogotá exemplifies the argument that informality is not an unregulated system opposed to the formal but a deregulated system positioned in a gray continuum between the 'whiteness' of legality and the 'blackness' of illegality (Roy, 2009; Yiftachel, 2009; Fernandes, 1997).

3.6. PROPERTY RIGHTS IN COLOMBIA: THE LONG PROCESS TOWARDS A SOCIAL NOTION OF PROPERTY

Because of its complex geography more than 75 percent of lands in Colombia were public by 1850 (Legrand, 1986). Private lands were highly concentrated and *haciendas* of more than 10,000 hectares near Bogotá were common (Jaramillo Uribe, 1994). By that time the Colombian State decided to expand the agricultural frontier as a way to cope with two of its main problems: lack of public revenues and social conflicts over land. To solve the first, public lands were privatized through debt certificates that could be acquired in the capital market (Melo, 1994). As roads and railways were built, land prices increased encouraging elites to secure ownership rights to realize speculative profits in the long term (LeGrand, 1986). That is why, in 1927, a political analyst complained that the government had shown an 'inexplicable urge' for finding

private owners for public lands but not for finding farmers (Lopez, 1927). Large-scale speculation with real estate also was possible because low property taxes guaranteed that the possession of non-productive land was no liability.

To solve the second problem, social conflicts, the Colombian State chose to promote the colonization of lands by granting titles to families that improved public parcels (Fajardo, 1994). In this way, Colombian landed classes were able to block any attempt of redistribution transferring the cost of solving rural conflicts to the public domain, a pattern of socialization of costs and privatization of benefits that is similar to the one created through the pirate subdivision system in Bogotá. Nevertheless, colonization did not solve social conflicts because land entrepreneurs illegally appropriated the newly colonized areas (Legrand, 1986). The final results of this dynamic have been more land concentration and more land conflicts. According to Ocampo et al (1994) in 1960 almost 60 percent of land in the county was property of 3.2 percent of owners. This concentration intensified during the second half of the 20th century. Today 0.04 percent of the population owns more than 64 percent of the land in the country (*Semana*, 2008). Land redistribution has been the main justification used for the two biggest guerilla groups, the Revolutionary Armed Forces of Colombia (FARC) and the National Liberation Army (ELN), in their forty-year struggle against the Colombian government. In fact, although civil unrest in Colombia is a complex phenomenon associated with the "process of state formation and reformation" (Roldán, 2002: 28), studies about Colombian violence have suggested that it is correlated with land conflicts (Roldan, 2002; Le Grand, 1986).

In the 1930s, the progressive administration of Alfonso Lopez Pumarejo tried to curb agrarian unrest by introducing a constitutional reform that included the concept of property as a 'social function' implying that property not only means rights but also

responsibilities. The main legal mechanism to control land speculation was the public right to eminent domain for estates that were not used over a period of 10 years (later 15 years). However, this reform was just a 'rhetorical initiative'[21] (Maldonado, 2001) because its application was resisted by land entrepreneurs who were supported by the Conservative Party and the legal tradition of the Civil Code which saw property as an 'acquired right' (Maldonado, 2001). Indeed, according to Roldán (2002: 17) the "land reform law confirmed only a limited number a squatter claims, making the validity of petitions not initiated before 1934 much more difficult to prove".

In this way, the constitutional precept of the 'social function of property' was not fully developed, and the laws that it inspired were carefully formulated to protect the interests of landowners. One law in 1936 imposed the obligation on municipal governments to allocate between 3 percent and 5 percent of the budget to social housing, but the law did not give them powers to expropriate urban land. Another law in 1943 gave this authority but under the condition of 'fair' compensation. The Law of Urban Development in 1947 imposed on municipalities the obligation to create master plans but it did not give them strong mechanisms to intervene on private property rights (Maldonado, 1999).

Difficulties in the implementation of the notion of a 'social function of property' were evident in the long process of the Law of Urban Reform. Since the 1960s twelve distinct projects of law sought to solve the social problems created by rapid urbanization through mechanisms of recovery of socially created values and tools to curb land retention. Just one of these projects (the most modest in 1978) was approved but it was declared unconstitutional shortly after approval. It was not until 1989, under

[21] "Under Colombian practice, acts of Congress set general policies, but implementation depends on follow-up at the nation executive level and at the municipal level" (Doebele, 1998)

the administration of Virgilo Barco of the Liberal Party, that the Law of Urban Reform was passed by the Congress (Maldonado, 2006).

This legal change was complemented by the new Constitution of 1991 which reaffirms that property is not a fundamental right but a social and ecologic function that implies responsibilities. Also, the law mandates that compensation should take into account the interests of the community and states that the costs and benefits of urban development must be distributed equitably. For these reasons Doebele (1998: 6) called the Colombian Constitution of 1991 a "remarkably innovative document on many aspects of urban land reform".

However, three years later the Colombian government concluded that the Law of Urban Reform of 1989 was inoperative because of the resistance of landowners and developers (Maldonado, 1999) and started a new process of reform that ended up deepening the notion of 'social function of property' with the new Urban Development Law of 1997. This law declares that the public through the municipal government can recapture up to 50 percent of increases in land values created by regulations and public actions using impact fees and land value capture taxes. In addition, the law states that developers should provide the needed infrastructure or pay the equivalent as an exaction. According to Doebele (1998: 6) "with this legislation, Colombia has enacted into national policy the basic premise of Henry George's writings (…), few if any other countries have attempted to so directly incorporate Georgian principles into actual legislation".

As the case with its predecessor, the implementation of this law has been very difficult. Land entrepreneurs have argued that these regulations increase housing prices by increasing land scarcity and costs of development (Maldonado, 2001). As an

example, a survey conducted by the Colombian Real Estate Association about the Law of Urban Development of 1997 shows that 67 percent of developers think that it increased land values in Bogotá and 50 percent believe that it increased housing prices (FEDELONJAS, 2007) even though academic research has shown that the new regulations have decreased land values by 23.7 percent on average, a result that follows the theoretical propositions of land economics about the capitalization of charges in the price of land when the supply is relatively inelastic[22] (Borrero and Morales, 2007).

3.7. CONCLUSION: INFORMALITY AND NATURAL PROPERTY RIGHTS

If the institution of natural property rights reduces the four ideal logics of allocation of the built environment to land entrepreneurialism and informalization is not related to resistance but to the dynamic of privatization of benefits and socialization of costs of urbanization, then addressing informality requires not its 'formalization' but the creation of a new type of 'formality' based on a different notion of property rights. This argument is contrary to some influential theoretical and political discourses like the property rights movement in the United States (Jacobs, 2008, 2004) and the ideas of the Peruvian economist Hernando de Soto (de Soto, 2000, 1989) that celebrate private property as a strategy for development and even as 'an answer to terrorism' conceptualizing natural property rights as an univocal and historically determined notion that sustains liberty, justice, and free-markets[23] (Krueckeberg, 1995).

[22] Another complaint of developers about the Law of Urban Development of 1997, longer times for development approval, seems to be justified. According to Cities Alliance (2006) just 39 percent of the development plans presented to the planning office were approved between 2000 and 2005.

[23] Free Trade Agreements and other forms of global governance are proposing an ultra-natural notion of property rights, with partial takings subject to compensations at market prices. For a discussion see Warner (2009) and Warner and Gerbasi (2004).

However, property does not necessarily entail a natural right. First, property is not a univocal concept because it has different dimensions. For instance, nine separate kinds of property rights have been identified in the literature: possession, use, alienation, consumption, modification, destruction, management, exchange, and profit taking (Krueckeberg, 1995). Classical economists differentiated between the rights to use and the rights to exchange. Indeed, the first drafts of the Napoleonic Civil Code of 1804 defined the right to properties (in plural) but this reference was replaced by the right to property (in singular) in the final version to facilitate the commodification of land and to privilege the exchange value over the other dimensions of property (Maldonado, 2001).

Second, arguing that history legitimates natural rights is inaccurate because property is a concept in constant development that has changed through time according to social and technological contexts (Jacobs, 2008). Krueckeberg (1995) describes the transformation of practices of property in the United States from the Native American concept of property as ownership of the product of labor, to the English colonial concept of property as ownership through possession, to the modern concept of property as ownership of profits made by selling. Jacobs (2004) argues that property evolves with economic development and rich societies are more open to regulations because their wealth is less represented in real estate. Indeed, the legal concept of property in the Napoleonic Civil Code cannot be understood without referring to its historical context: individual property rights were necessary for the abolition of feudal privileges and for the limitation of the arbitrariness of the king's rights.

Third, the idea of natural property rights as a foundational condition for liberty is often justified using a mistaken reading of the political philosophy of John Locke. It is true that Locke proposed in his "Two Treatises of Government" (1689) that real property is

a right that exists prior to the state, because land is necessary for three natural conditions of humanity: survival, work, and freedom. But it is also true that Locke stated that property is limited by the same natural conditions that legitimize it. Property is not a right anymore if it exceeds the needed share for survival, or if it is not the result of personal work, or if it impedes the freedom of other individuals (Maldonado, 2001). Based on this logic, Krueckeberg (2004) argues that de Soto's ideas are not an ethically satisfactory theory of property because they do not contain a specific statement about a 'just distribution' equivalent to Locke's constraints on property in regards to spoilage, sufficiency, and charity.

Fourth, the claim that natural rights are just because owners deserve the profits from their property only applies if these profits are the product of their 'good efforts' and not the result of third party actions (Krueckeberg, 1995). This is the basic idea of Henry George who argued in his "Progress and Poverty" (1789) that property is a social institution and its rights are counterbalanced by the responsibility to return to the community all rents created by the society (Brown and Smolka, 1997).

Fifth, the claim that natural rights are a condition for free markets fails to acknowledge that competitive markets demand property rights not only over assets and physical goods but also over external effects. Because externalities are reciprocal, in some cases they can be addressed within the market logic through voluntary bargaining arrangements creating pricing mechanisms that allow the 'internalization' of third party effects (Coase, 1960) but most of the time the definition and assessment of extra-contractual responsibility is difficult and expensive (Webster and Lai, 2003). In these cases markets need regulations over property to achieve efficiency. That is why, Jacobs (2004) describes the 20th century as the era of major assaults on the property rights bundle but, at the same time, as the era of consolidation of markets.

For these reasons, addressing land entrepreneurialism and informality requires a re-conceptualization of property based on the dialectic relationship between the different dimensions of property rights. A broader notion of property that takes into account not only the rights of the owner but also his or her responsibilities to the community could prevent the process of privatization of benefits and socialization of costs produced by city growth. Such an expanded definition would enable a more equitable allocation of the built environment through the market, rational-comprehensive, participation, and resistance logics.

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CHAPTER 4

NO-GROWTH MACHINES: WHY URBAN SERVICES ARE UNDERPROVIDED IN BOGOTA, COLOMBIA

ABSTRACT

In this paper, I analyze the paradox of why urban services are under-provided in cities in the developing world when servicing can increase land values by much more than its cost. To that end, I conduct a historic analysis of the process of urbanization of Bogotá to argue that the scarcity of infrastructure is structural to the process of production of the built environment because this scarcity is compatible with the incentives of the stakeholders involved in the production and consumption of the urban space. As part of the argument, I describe how the pattern of under-provision of urban services has been the result of a system of financing urban growth based on tariffs and cross-subsidization and how this system has produced an outcome that is collectively inefficient but nevertheless apparently 'rational' from an individual perspective. Finally, I discuss the political economy implications of the argument analyzing the possibilities of change.

4.1. THE PARADOX OF UNDER-PROVISION OF URBAN SERVICES

The provision of urban services in cities of the developing world has failed to keep up with the growth in demand. As a result, many urban dwellers lack piped water, appropriate sewerage, reliable electricity, and adequate roads. According to Acioly (2007) one third of urban citizens are living in slum conditions across the world. That

proportion accounts for nearly 1 billion people now and may reach up to 2 billion in 2020.

The scale of the lack of land with urban services in cities in the developing world posits a fundamental question for planning: why is infrastructure under-provided when it can increase land values by much more than its cost? This paradox, which has been termed the 'under-investment anomaly' (Shoup, 1994), is exemplified by Smolka (2003), who studying a sample of 10 major Latin American cities finds that the benefits of infrastructure and urban services costing US$25 on average can represent up to US$70 per square meter of land.

The paradox of the 'shortage of serviced land' in the developing world (Shoup, 1994) is even more puzzling if we compare the situation with cities in the United States. In their classical work, 'Urban Fortunes: the Political Economy of Place', Logan and Molotch (2007[1987]: 32) argue that the valorization produced by urban services in American cities has led to 'growth machines': coalitions that push "to create the conditions that will intensify future land use in an area" by constantly extending utilities to incentivize new developments.

Growth machines increase 'aggregate rents for those in the right position to benefit': primarily landowners and developers but also politicians, local media, utility companies, and some auxiliary players such as universities, museums, theaters, professional sport teams, unions, retailers, and corporate capitalists. In the United States, as the authors point out, the belief in growth has resulted in 'over built infrastructures' and 'fiscally irrational projects'.

In this paper I study the paradox of under-provision of urban services by analyzing the historic process of urbanization of Bogotá, Colombia a city where more than 7,468

hectares (25.5 percent of the urban area) and almost 1 million housing units (50 percent of the housing stock), have been developed informally without urban services, property titles, or planning permissions (*Secretaría del Habitat and Universidad Piloto de Colombia*, 2008; Cities Alliance, 2006; Hataya, 1996; Jaramillo, 1994, 1980).

My argument is that the pattern of under-provision of urban services in Bogotá has been the result of a system of financing urban growth based on tariffs and cross-subsidization. This system could be considered a 'rational' alternative because it is compatible with the incentives of the main stakeholders involved in the production and consumption of the built environment within the political, economic, and social context of a city characterized by high levels of poverty and inequality.

In this regard, Bogotá is considered one of the most spatially segregated cities in the world (Mohan, 1994). In addition, the Gini Coefficient in terms of actual income, a measure of inequality, has been consistently around 0.5 in the city. By contrast, it is usually estimated around 0.35 for developed countries and, even though it has decreased moderately in the last years, the percentage of population living below the poverty line has traditionally remained around 50 percent (*Bogotá cómo vamos*, 2005; Mohan, 1994; Ocampo et al, 1994).

In the next section of the paper, I describe how 'no-growth machines' composed by different actors from landowners and formal developers to public utilities and low income households have benefitted from the pattern under-provision of land with urban services throughout the history of the city. Then, I study how, despite its apparent 'rationality', this pattern has produced an outcome that is collectively inefficient and, finally, I conclude with a discussion of the possibilities for change.

4.2. THE 'RATIONALITY' OF UNDER-PROVISION

In economic theory an agent is said to be economically rational if he is maximizing his utility according to a previously defined set of preferences. However, this perfect model of rational choice is affected by the difficulties of considering 'all alternatives and all information', simultaneous decision problems, game/strategic behaviors, and the changing nature of preferences (March, 1978). For that reason, I am proposing here a weaker test of rationality for the study of the pattern of under-provision of urban services: an analysis of the compatibility of the incentives of the main stakeholders in the process of production and consumption of the built environment.

These incentives are defined in particular economic, social, and political contexts. As Fainstein (2000: 457) points out, interests cannot be inferred directly from relations to the means of production since "a particular structural position (e.g. capitalist) does not automatically produce a particular policy position (e.g. deregulation)". Thus, my methodological approach is a historical analysis about how each one of the main stakeholders in Bogotá's process of urbanization have benefited from the scarcity of urban services.

To that end, in this section, I will look at landowners, formal and informal developers, planners, utility companies, low-income households, the national government, international agencies, and politicians drawing information from primary sources (such as urban plans, laws, policy documents, public budgets, and cadastral bases) and secondary sources (such as academic work and newspaper articles) with the objective of analyzing the incentives of each category of stakeholders and how they relate to the pattern of scarce urban services.

Landowners

Bogotá is located in the middle of a savanna known for its high agricultural productivity. For this reason, land surrounding the city has been extremely concentrated in private hands since colonial times. In the 19th century *haciendas* with more than 10,000 hectares were common (Jaramillo Uribe, 1994). During the 20th century individual properties in the outskirts of the city were up to four times larger than the city itself (del Castillo, 2003). In the 1980s, 70 percent of the land surrounding the city was owned by 1 percent of all property owners (Robledo, 1985). In 2001 less than 5 percent of properties occupied almost 70 percent of the area in the municipalities surrounding Bogotá (Mesclier, 2005). Consequently, public ownership has been, and is, rare: in 2008 only 6 percent of the urban area and 1.3 percent of the administrative area in Bogotá is classified by the Cadastral Department as owned by the state (my own calculation based on UAECD [2008]).

Property-owning classes in Colombia have always been involved in different activities to maximize their profits (LeGrand, 1986). Retaining land from the market for speculation purposes has been one of their main businesses. Because property taxation has been traditionally low, holding vacant land has not been a liability. Revenue from property taxes has represented around 0.5 percent of the city's Gross Regional Product (my own calculations based on data from DNP [2009] and SDP [2000]) when the figure for cities in the United States can reach 3 to 4 percent (Smolka, 2003).

Because of the scarcity of land with urban services, land values in areas with infrastructure, generally occupied by the most profitable uses (commercial, institutional, industrial, and residential of high- and middle-income) have increased dramatically. Between 1960 and 2005, land values in non-centric areas have increased

at geometric annual rates ranging from 2.94 percent to 8.04 percent in real terms. That means that land values in the formal city have doubled several times in the last 50 years. For instance, in *Cedritos*, a mixed high- and middle-income neighborhood in the north of the city, land values increased almost 26 times between 1963 and 2005 in real terms. The results could have been more dramatic if a severe crisis had not affected the construction industry in 1997. Until that year real land prices in this neighborhood had increased 38 times (LONJA, 2005).

The dynamism of land values in the formal city has reinforced speculative tendencies to the point where vacant lots with signs of 'This lot is not for sale' are a ubiquitous part of the urban landscape in Bogotá. In 2008 almost 16 percent of the area of the city was classified by the Cadastral Department as 'urbanized but not built', meaning that it has urban services but has not been developed. More than one thousand hectares (3.1 percent of the urban area) has been defined by the Planning Department as 'fattening lots': vacant lots being held off the market for speculation purposes (UAECD, 2008; SDP, 2009). It has been calculated that some 100,920 low-income housing units could be built in these lots (SDP, 2009).

Land values also have increased exponentially in peripheral areas with no infrastructure and in areas outside the urban limit. The values of rural lands close to Bogotá can be between 5 to 13 times those of more distant municipalities. This dynamic is reinforced by the strong demand for land due to income generated by illicit activities (Colombia is the principal producer of cocaine in the world), the relative security and safety of property rights near Bogotá compared with the rest of a country that has suffered from civil unrest during most of its independent life, and the status and symbolic value provided by land ownership (Mesclier, 2005). Moreover, these properties can be temporarily rented to flower growers, one of the most important and

profitable legal industries in Colombia, or used for pastures and cattle. Therefore, retention of land from the market is a long term tendency in the outskirts of Bogotá and big properties are urbanized very slowly (Mesclier, 2005).

The percentage of land in non-urban uses in the total urban area of Bogotá reaches 32.44 percent (my own calculations based on cadastral data from UAECD [2008]). In the United States, by contrast, the percentage of vacant land, a classification including remnant land, land with physical limitations for development, reserve and speculative parcels, and derelict land, is, on average, 15.4 percent of the incorporated urban areas ranging from 9.6 percent in cities of the northeast to 19.3 percent in cities in the sprawling south (Pagano and Bowman, 2004).

The characteristics of Bogotá are common within the context of Latin American cities. For instance, Fernandes (1997) states that between 30 percent and 40 percent of the urbanized land in Brazilian cities is vacant and Smolka (2002) shows that urban empty spaces are 32 percent of the area of Buenos Aires, Argentina and 26.6 percent in Guadalajara, Mexico. This has increased urban land values in the region. According to Smolka (2002), a square meter of serviced land in the periphery of a typical city in Latin America, where the minimum monthly wage is US$130, costs between US$32 and US$172. In contrast, in the U.S., where the minimum monthly wage is approximately US$950, this cost ranges from US$28 to US$145 in a city like Boston. That means that a Latin American minimum wage can buy only 0.8 to 4 square meters of land in the formal markets while the minimum wage in the U.S can afford 7 to 34 square meters in the periphery of the main cities. This comparison is even more dramatic if we take into account the high rates of poverty and informal labor in Latin America.

The main incentive for the retention of land is the expectation for valorizations caused by high- and middle-income developments in the future. As I will explain in detail in the next section, due to the pattern of spatial segregation in the city, some landowners in peripheral non-serviced areas with low formal demand, especially in the south and west, have commercialized their land to low-income households through 'pirate subdivisions': illegal parcelings of peripheral land sold by the legal owner without planning permissions and without basic infrastructure to poor people who build their own houses through the process of self-construction (Doebele, 1977). Land values in peripheral informal areas have followed the same dynamic pattern of the formal city increasing at a geometric annual rate of 3.70 percent in real terms from 1960 to 2005.

Due to the concentration of land and the tendency to retain it from the market, Bogota's landholders have always been opposed to any type of regulation of land markets and have configured a dynamic of 'land entrepreneurialism' characterized by the privatization of the benefits of city growth and the socialization of its costs. For instance, del Castillo (2003: 78) describes the case of a banker at the beginning of the 20th century who in response to a petition made by the municipality asking to rent part of his lands, refused, saying that he needed them to 'sunbathe'[24] and declaring his interest to donate the property to Paris, France after his death just to impede its public use.

Pirate subdividers

In contrast to other Latin American cities, a specific characteristic of Bogotá is that its informal settlements are not the product of invasions or squatting. According to Gilbert (1981) only 0.7 of the housing stock was the product of the collective or

[24] In the original: '*para tomar el sol'* (del Castillo, 2003: 78).

individual appropriation of public or private land. Informal settlements in the city are the product of pirate subdivisions, oligopolistic markets controlled by actors called 'pirate urbanizers'. However, since they do not urbanize anything beyond the land assembly process, they should be called 'pirate subdividers' (Doebele, 1977).

This actor is usually a person of middle- or low-income background who acts as an intermediary between landowners and low-income households selling individual illegal subdivisions. To maximize profits, the pirate subdivider uses strategies like selling the first lots for a lower price (or even giving them out for free) in order to attract more demand, and leaving bubbles of vacant lots for speculation (leapfrogging) (Fernandes, 1997). For these reasons the pirate subdivider realizes large profits. According to information cited by Smolka (2002), a pirate lot in Bogotá can be sold for US$16 to US$19 per square meter, when the agricultural land price is less than US$5 per square meter. In his study of 7 pirate subdividers in Bogotá, Doebele (1977) finds that they collect twice the value of their purchase within the first months of operations achieving a rate of profit of more than 300 percent. Other authors estimate more modest rates of return, Mohan (1994), citing information from Carroll, estimates a rate of return between 25 percent and 33 percent but reckons that a minority of pirate subdividers 'clearly do make extremely high profits'. The best indicator can be the answer of one pirate subdivider to the question "How would you describe your urbanizations? Profitable, if not, why would I be involved in this?" (Morales, 1993: 86).[25] This profitability is an important incentive for the creation of new informal settlements even if we take into account that their promoters face 'entry barriers' in the form of risks and bribes for public officials (Jaramillo, 1999; Gilbert, 1981).

[25] In the original: *Cómo describe usted sus urbanizaciones? Lucrativa, o si no, para que me hubiera metido en esto?* (Morales, 1993: 86)

As I will explain later, in the lower segments of demand there are no formal housing alternatives that can compete with the pirate subdivision, so their prices are usually set just below those of the formal market. As land with urban services becomes scarcer, the pirate subdividers face less competition and can increase their prices. An indicator of this is the fall in the average area of pirate lots and the increase in the gross densities in informal areas. According to the information about legalization from Bogotá's Planning Department (SDP, 2007; SDP, 1997) the average gross densities of legalized informal lots were 33.74 lots per hectare during the 1960s, 41.61 in the 1970s, 48.37 in the 1980s, 64.56 in the 1990s, and 72.83 after 2000. Molina (1990) shows how pirate subdividers decreased lot sizes in response to the establishment of a municipal policy of 'minimum requirements' that attempted to capture the demand for informal lots by allowing formal developers to bypass many planning standards.

The pirate subdivider also includes in his price the expectation of valorization for legalization and up-grading programs (Abramo, 2007) making promises about future infrastructure and, in many cases, organizing social mobilizations demanding services from the municipality (Rocha et al, 2006). The period between development and legalization varies and has been decreasing through the years from more than 24 years for areas developed before the 1950s to less than 4 years for areas developed after 2000 (*Secretaría del Habitat and Universidad Piloto de Colombia*, 2008). By the year 2005, almost 6,000 hectares had been legalized in the city, nearly 80 percent of the informally developed area by the year 2000. Figure 4.1 shows the location of the regularized informal settlements in Bogotá according to the decade of intervention. Note their progressive move to the periphery of the city and their higher concentration in the south and west, areas that have been traditionally zoned for low-income high density developments as I will describe in the next section.

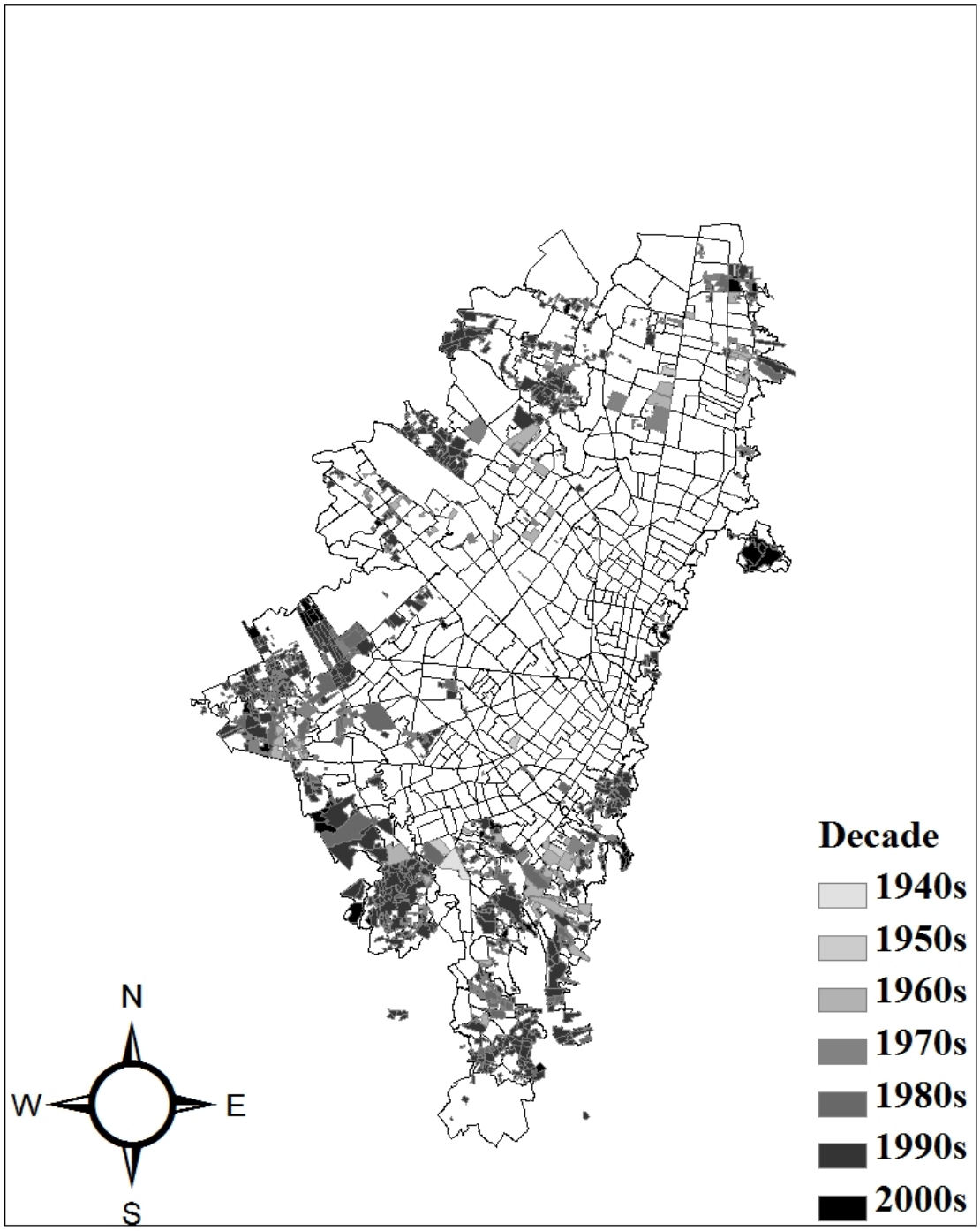

Figure 4.1 Regularized informal settlements in Bogotá
Data source: DANE (2006), SDP (2007). Author's own elaboration

Planners

Due to its location in the Andean region at 2,600 meters above the sea level, its difficult access, and the lack of adequate road networks connecting the city with the main coasts, Bogotá's integration with the rest of the world has been very weak historically. Even as recently as in the 1990s and 2000s, the percentage of Bogotá's exports with respect to the Gross Regional Product has fluctuated between 5.9 and 7.2, whereas in Colombia, a rather closed economy by international standards, the figure was 16 percent on average (Blanco, 2005). Because of its geographical isolation, the Bogotá of the beginning of the 20th century looked much like the city did during the Spanish colonial times and was regarded as a backward 'latecomer' to modernization even by Latin American standards (Zambrano, 2007; del Castillo, 2003).

This situation has been a main concern for Colombian modernizing elites. As early as 1867, a bourgeois intellectual lamented that "if one examines the condition of the various social classes that make up Bogotá, the portrait that results from this description can only crush the spirit (…) of all the capital cities in South America, Bogotá has remained the most backward, unable to sustain comparison with Caracas, Lima, Santiago, or Buenos Aires" (Samper 1995[1867]: 105). In the 1920's Ricardo Olano, a merchant from Medellin, advocated for hygienic cities that would allow Colombians to evolve from "the moral and material filthiness that the Colony left" to the "new urbanist ideas that advocate for clean, lightened, healthy, and happy cities" (Olano quoted in del Castillo, 2003: 75).

However, the elite's objective of building modern and hygienic cities was never accompanied by a commitment to fund its costs, so plans have been only partially implemented. Furthermore, planners have faced the difficulties of planning a city

characterized by inequality that grew very rapidly from a population of 145,000 and an urban area of 570 hectares in 1910, to 676,292 inhabitants and 6,647 hectares in 1950, and to 6,302,880 inhabitants and 29,221 hectares in 2000 (Rincón, 2006; Cities Alliance, 2006).

Attempts to 'modernize' Bogotá through comprehensive planning started in the early decades of the 20th century when Olano proposed the need for a *plano futuro* for Colombia's principal cities. In the 1930's the national government hired the American urban planner Harland Bartholomew, who has been described as the first full time planner employed by a city in the US and one of the fathers of American city planning, to study the possibility of a 'complete urbanism plan' for Bogotá. In 1933 the Austrian planner Karl H. Brunner, famous at the time for his *Manual de Urbanismo,* was appointed as the first director of the newly created planning department in Bogotá where he worked for the next 15 years (del Castillo, 2003).

In 1947 the city was visited by the renowned Swiss-French urbanist Le Corbusier, considered one of the pioneers of modern architecture, who commented that Bogotá reminded him of "one of those girls who at 17 decide to leave their homes to enter in the adventure of a life without control" (quoted in Zambrano, 2007: 127). In 1948 the assassination of Jorge Eliécer Gaitán, a leftist political leader, caused a massive riot in the city described in Colombian history as *Bogotazo*. The actual consequences of this riot are still a matter of debate with estimates of deaths varying from 600 to more than 3,000 and the number of destroyed buildings varying from dozens to hundreds (Zambrano, 2007; Aprile-Gniset, 1983). But in any case the partial destruction, which was concentrated in the city center, was seen by planners as the perfect opportunity to build a 'beautiful city from the rubble'.

For that reason, Le Corbusier was quickly hired to design a 'regulatory plan' along with his disciples Joseph Sert, a future Dean of the Graduate School of Design at Harvard University, and Paul Wiener, the designer of the Washington Square in New York City. The total amount of the contract was US$223,000 an astronomical figure that represented almost 10 percent of the total revenue from property taxes in 1948 (My calculation based on data from SDP [2000] and Aprile-Gniset [1983]). The project was scheduled for three years and it would be developed by the urbanists from their offices in Paris and New York. However, the results of this 'urbanism by mail', as the plan started to be called in Bogotá, were inadequate because it did not include population projections and geological and topographical studies (Aprile-Gniset, 1983). In effect, the plan assumed a population of 1.5 million in Bogotá for the year 2000 but by the year 1964 the city had already surpassed that number (Aprile-Gniset, 1983). Indeed, in the year 2000 the population of Bogotá was more than 4 times the estimations of the plan. Additionally, there were disputes about zoning decisions and controversy regarding the employment of 'foreigners'. Thus, the plan that was supposed to guide the growth of the city for the next 50 years was never implemented.

From that moment on, Bogotá's planners have tried to accomplish their old ideal of a hygienic and modern city through almost 10 comprehensive plans. These plans have effectively reproduced and reinforced the traditional pattern of segregation by mandating low densities for high-income neighborhoods in the north-east and high densities for low-income neighborhoods in the south and west (Rincón, 2006; Gilbert, 1996). Furthermore, comprehensive planning has traditionally defined higher requirements of infrastructure for high-density areas in the south and west which, taking into account the pattern of spatial segregation in the city meant an increase in the cost of developing low-income areas.

The 'impossible standards' for low-income housing defined by these plans have resulted in an 'unregulated' informal/unplanned/unserviced land market in the southern and western peripheries and a protected formal/planned/serviced land 'market' in the city center and the north. Thus, planners have been able to implement their ideal city in one part of the city through the concentration of urban services in the center and north responding effectively to the elite's interests of creating adequate spaces for the reproduction of international patterns of production and consumption.

Utility companies

Utility companies in Bogotá have been conceived as decentralized, commercially-oriented, and self-sustaining agencies. As it was the case in other Latin American cities, they were created as private firms at the end of the 19th century often funded by American and British capital. Decades after, utilities were acquired by the municipality through more than fair compensations when the size and complexity of the operation demanded a centralized coordination (Gilbert, 2007, 2006, 1990; Zambrano, 2007; del Castillo, 2003; Mohan, 1994; Gilbert and Ward, 1982). Because of the utility companies' commercial orientation and the weakness of property taxation in the city, the expansion of public services has been funded primarily through cross subsidies, valorization fees, and debt.

Cross-subsidies have a long tradition in Bogotá (Coing, 2005). Through this system high-income households pay tariffs that are higher than the average long term cost of service provision to contribute to cover the deficit produced by low-income users that pay tariffs that are considerably lower than the average long term cost. In 1973 high-income groups paid 5 times more than low-income groups per cubic meter of water (Gilbert, 1990), by 1995 the ratio increased to 7.4, but by 2007 it had dropped to 4.6

(Gilbert, 2007). For that reason, utility companies have first supplied high-income groups and only have expanded the service to low-income areas if the contributions from the first category can cover the long term costs of the expansion.

Another effect of this funding pattern is the over reliance of Bogotá's public budget on user charges. During the 1960s and the 1970s user charges financed more than 50 percent of all expenditures and the three biggest utility companies (Electricity, Water, and Telephones) accounted for almost 75 percent of the total municipal budget (Mohan, 1994). A study by the World Bank found that Bogotá financed 48.5 percent of total public expenditures through user charges in 1972 while the average in other 25 cities in the developing world was just 7.2 percent (Mohan, 1994).

The combination of a redistributive role and a commercial orientation through the system of cross-subsidization has been a characteristic of utility companies in Bogotá since they were acquired by the municipality around the 1920s (Jaramillo, 1995). During the second half of the 20th century the progressive character of the public services in Bogotá increased as tariffs for high-income households rose and tariffs for low-income households fell (Mohan, 1994).

In 1994, with the objective to promote efficiency, competition, and privatization, a new law governing the system of cross-subsidies was enacted in Colombia under the neoliberal government of Cesar Gaviria (Law 142 of 1994). According to this law, tariffs should reflect the average long term cost of service provision and subsidies should be covered with resources from the general budget. However, transferences from the general budget have not been enough to compensate utility companies for decreasing revenues caused by the decrease in the tariffs for high-income households (Gilbert, 2007). As a result, the progressiveness of the cross-subsidies has declined

and low-income households have experienced a considerable increase in the proportion of income spent on urban services (Coing, 2005).

Valorization fees are betterment charges that allowed municipalities to finance infrastructure improvements, especially road networks, in built-up areas by charging the cost to beneficiaries according to spatial proximity (Maldonado, 1999). According to Smolka and Amborski (2000), 16 percent of all local public expenditures in Bogotá were financed through this mechanism in 1968. By 1996 the proportion had fallen to 6.6 percent. As with the case of the cross subsidy the valorization fee also reinforced the concentration of infrastructure in high-income areas because it was based on proximity (Maldonado, 2006; Mohan, 1994).

Utility companies have also relied on loans and debt. The same World Bank study quoted above found that net borrowing represented 23.5 percent of all local public expenditures in Bogotá in 1972 compared to 5.1 percent for the 25 developing cities analyzed (Mohan, 1994). In 1970 public debt in Bogotá represented 12.28 percent of the city's Gross Regional Product, by 1990 the proportion had reached 28.53 percent (my own calculations based on data from DNP [2009] and SDP [2000]). In the water company, for instance, loans represented 30 percent of the revenues from 1970 to 1985 (Jaramillo, 1988). In 1950 more than 96 percent of the public debt was contracted with local banks. In 1962 external sources surpassed internal ones and from that year to the 2000s almost 80 percent of the public debt has been contracted with international institutions (SDP, 2000). The main external sources of credit have been the World Bank and the Inter American Development Bank (Gilbert, 1990).

The strong reliance on credit has reinforced the commercial orientation of utility companies in Bogotá. Since the 1950s local banks were able to appoint representatives

to the governing board of the main utility companies isolating their operation from day-to-day politics. Traditionally the governing board has had considerable power to the point that it can approve not only budgets but also investment plans (Mohan, 1994). For these reasons, public utilities in the city have decided their expansion plans in a commercial logic oriented by the need to recover the investment and balance costs and revenues and by the interests of the elite classes represented in the utility companies' governing boards. From this perspective, the pattern of under-provision of urban services has been compatible with the utilities' interests to remain commercially viable and self-sustainable.

Developers

Historically, developers and landowners have been overlapping categories in Bogotá. Initially, the operation of 'developers' only consisted in selling empty lots to the final user, mainly high- and medium-income households, who subcontracted the construction with small firms or independent workers. According to Jaramillo (1994, 1980) this method of customized production represented 37.72 percent of the legal housing production between 1938 and 1951, 29.87 percent between 1951 and 1964, 25.74 percent between 1964 and 1973, and 22.62 percent between 1973 and 1985. Most developers were initially landowners. Others started acquiring lands massively in the surroundings of the city in the 1930s when the economic crisis forced agricultural landowners to sell their lands. In any case, from the start developers were more focused on the transaction of land than in producing housing (Jaramillo, 1994, 1980). For that reason, they can be categorized more appropriately as 'land entrepreneurs'.

In the 1950s, with the consolidation of a modern mortgage lending system and with public policies designed to create a capitalist sector of housing construction, these land

entrepreneurs started the biggest construction companies. After 1970, they created financial institutions taking advantage of new public policies directed at increasing housing construction through preferential interest rates. In this way, the division between capitalist developer and landowner that enabled the implementation of laws to control the process of speculation in Europe (Topalov, 1984) or Brazil (Fernandes, 1997) was not present in Bogotá. Landowner, developer and banker have been either the same actor (Jaramillo, 1994, 1980) or, when different, have established alliances to minimize risks and maximize revenues (Maldonado, 2006).

During the first half of the 20th century land entrepreneurs focused on low-density developments for the high-income demand in the periphery, particularly in the northern part of the city. However, as car-ownership rose faster than the capacity of the road system, congestion increased affecting commuting times for the wealthy and inducing the return of this class to more central locations (Jaramillo, 1999; Amato, 1969). The increase in high-income demand for areas close to the city center pushed land prices in the already built formal city triggering processes of redevelopment and renovation of the housing stock.

According to Rincón (2006), two stages can be identified in this trend of 'densification through individual demolition': the first started after the *Bogotazo* the massive riot in April 9, 1948 described above. The partial destruction produced by this event triggered the premature demolition of the city's housing stock replacing it with high-rise structures oriented mainly to offices and commerce and, to a lesser degree, residential buildings. This renovation was not limited to damaged buildings since most demolished structures were not affected by the destruction of the riot (Aprile-Gniset, 1983). The reason for this was that the process was commanded by the pressure produced in land values by the increase in the demand for central locations.

For instance, the ratio of the value of the building to the value of the land in properties renovated after the *Bogotazo* was between 1:30 and 1:40 (Aprile-Gniset, 1983: 39).

The second stage was produced by changes in planning regulations in 1974 and 1979 that eliminated the concept of 'zone index' which defined relations between densities of construction, amenities, and infrastructure. These changes allowed the redevelopment of already consolidated areas, triggering a second wave of renovation of the housing stock in the high-income neighborhoods that were built in the northern part of the city during the 1950s and 1960s.[26] Because of this process individual single-family spacious units were demolished and replaced with 5 story multifamily buildings initially, and with 15 to 20 story multifamily buildings later (Rincón, 2006). In many cases this change was extremely rapid, for example in *El Nogal*, a single family neighborhood studied by Rincón (2006), perfectly sound housing was demolished just one decade after its consolidation.

This dynamic was induced by the pattern of valorization of land prices caused by the scarcity of land with urban services. According to LONJA (2005), in redeveloped neighborhoods like *La Cabrera*, *Rosales* and *Chico Oriental*, land values increased almost 14 times in real terms between 1960 and 1995. The rapid renovation of the housing stock has not only continued up to the present but also has expanded to middle-income neighborhoods.[27]

Even though built densities have increased because of high-rise construction, the densities in terms of people per hectare have not changed significantly because the

[26] According to Rincón (2006), this includes neighborhoods like *Antiguo Country, Nogal, La Cabrera, Chicó, Rosales, Bella Suiza, La Castellana, Santa Ana, Chapinero Alto, La Cabrera,* and *Porciuncula*.
[27] Including middle-income neighborhoods in the western part of the city like *Belalcazar, Nicolas de Federman, Campin, Normandia, Santa Isabel, Andes, Alcazares* and *Polo Club.* Currently, almost all high-income neighborhoods, and many middle-income ones, have been completely or partially renovated.

new apartments are spacious according to the preferences of the wealthy (Rincón, 2006) and because of the decreasing trend in household sizes. For these reasons, some authors comparing formal and informal developments in Bogotá have noted that the rich answered to the scarcity of land with urban services by substituting land with capital through high-rise construction while the poor substitute land with overcrowding (Molina, 2001; Mohan, 1994).

Another implication of this extremely rapid renovation of the housing stock has been the relative absence of the process of 'filtering down' as an alternative for low-income households. Filtering down, characterized as the process by which aged housing is downgraded from a higher to a lower demand level, has been an important source of affordable housing in the United States (O'Flaherty, 1996; Mills and Hamilton, 1989). The weakness of the process of filtering down in Bogotá is another factor pushing low-income households to informality.

Low-income households

The literature about informal settlements in Latin America has long argued that informality is a rational alternative for low-income households. At the end of the 1960s scholars like John Turner (1976) began to characterize informal housing as 'architecture that works' arguing that it matches the needs of the poor better than public or formal alternatives. One of the benefits of informality is its 'urbanistic freedom' (Abramo, 2007) because it allows the expansion of accommodations according to household size. As the family grows informal settlers will build new rooms or create new subdivisions (Gilbert, 1999). Also, informal settlements are a source of additional income because the lack of planning regulations allows for the construction of extra rooms to rent or the use of the first floor for commercial

activities. For instance, in his study of Bogotá, Doebele (1977) finds that 1/3 of informal settlers receive payments from renters. In addition, 1/5 receive income from commercial activities. This tendency is increasing because of the growing scarcity of land, Gilbert (1999) observes that 2/3s of the informal settlers studied in Bogotá obtain supplementary incomes from their houses. In contrast, the percentage of poor households in formal accommodations receiving payments for rental or commercial activities is only 11 percent.

In addition, informality decreases the cost of access to housing. With the process of self-construction, low-income households can unbundle the housing commodity reducing monetary payments and extending their expenditures through their life cycle (Mohan, 1994). In this regard, pirate subdividers have created a system of pricing according to the characteristics of their demand offering credit for poor and informal workers who are usually rejected by banks and financial institutions. According to Doebele (1977), in the typical sequence, buyers will pay a cheap 'separation agreement' that assures them that the pirate subdivider will not offer the lot to anyone else, then the buyer will make an affordable down payment[28] and the seller will deliver the 'promise of purchase and sale' which allows the immediate occupancy of the land. Buyers will waste little time in beginning self-construction (94 percent of informal settlers begin construction within a year as a way to ensure occupation). Because the monthly income of poor families fluctuates, the system, unlike formal alternatives, allows payments per semester. After three years the payments will decline and the settlers will be able to spend more money on the construction of the housing unit or in other needs like food and education (Vernez, 1974).

[28] The down payment can even be nonmonetary. Interviews conducted by Morales (1993) in pirate subdivisions in Bogotá show that in some cases lots were exchanged for home appliances and even for guns.

Another advantage of this system for low-income households is its lesser risk of eviction compared to invasions. Since they respect the 'sanctity' of private property, pirate subdivisions provide more security of tenure and more incentives for investment in the construction of the housing unit (Gilbert, 1981). Finally, informal settlements allow the opportunity of accessing social networks and reciprocity economies since the process of self-construction is often a collective effort (Abramo, 2007; Friedman, 1992).

Because they allow the minimization of monetary payments and the access to a reciprocity economy, informal settlements also have been considered an implicit subsidy to the formal economy since they help to keep wages at low levels (Doebele, 1977; Gilbert, 1998; Fernandes, 1997). In this way, not only commercial and industrial firms but also high-income households have benefited from informality through cheap labor.

The national government

The national government also has benefited from this pattern because the under-provision of urban services has allowed it to limit budgetary transfers to the city and to pursue a redistributive allocation of resources to other regions. In effect, in a country that traditionally has been recognized as one of the most fiscally decentralized in Latin America (Restrepo, 2005), the national and local government have always argued over the right allocation of resources to Bogotá.

As early as in 1923, the main newspaper in the city, *El Tiempo*, complained that the "capital of the Republic is full of unattended problems but it does not even have the revenues that it generates by itself" (quoted in Zambrano, 2007: 83). In 1941 the same newspaper insisted that the local budget was equivalent only to one fourth of the fiscal

revenues that it collected (Zambrano, 2007: 88). During the 1960s it was calculated that Bogotá contributed around 35 percent of Colombia's GDP but only received 6.5 percent of the national government's transfer of federal monies (Zambrano, 2007; Mohan, 1994). As recently as November 2009 one columnist still lamented that "*Bogotanos*, collect 52 percent of national taxes, produce 28 percent of the GDP, and only get back 8 percent of federal transfers, but we do not go around complaining about this" (*El Tiempo*, 2009).

These opinions, of course, discount the importance of the direct investment in Bogotá by the national government which has been important although it has decreased with the consolidation of the decentralization process. But even taking that into account, the claim that the city has subsidized other regions in the country appears reasonable. For instance, the Finance Department in the city (SHD, 2007: 74) has calculated that the direct and indirect investments of the national government in Bogotá have been decreasing as a percentage of the national revenues collected in the city from 20 percent in 2000 to 12.6 percent in 2006.[29]

Moreover, insofar as the pirate subdivision system has functioned as a 'valve' for social discontent (Gilbert, 1998), it has prevented major open class conflicts in Bogotá allowing the national government to maintain public order in the capital of a country that has suffered from rural violence almost permanently since its independence (Gilbert and Ward, 1982).

[29] The situation was somewhat different in the 19th century since the country was largely an agrarian economy. In 1867 Miguel Samper wrote that "the course of three centuries has not taken from the capital its parasitic character. Many of the taxes and revenues collected by the national and departmental governments from those living in other parts of the country continue to be invested in the capital. Indeed, it can be said that the main industry of Bogotá consists of attending to the spending of the budgets" (Samper 1995[1867]: 116).

International organizations

Colombia has a long tradition of international missions advising the government on the implementation of public policies. At the beginning of the 20th century the American Kemmerer mission modernized the monetary institutions, a German mission restructured the education policies, an Italian mission changed the penal system, and a French-Swiss mission reformed the armed forces (Zambrano, 2007). International organizations have also been very active in the country. In 1950 the World Bank, by invitation of the Colombian government, sent their first mission to a developing country headed by the renowned Canadian economist Lauchlin Currie. In 1967 the International Labor Organization (ILO) sent an employment mission led by the British economist Dudley Seers. In 1970 the United Nations Development Program (UNDP) conducted a comprehensive urban development study based in Bogotá known as Phase II study. In 1975 the World Bank started its first City Study in Bogotá and Cali led by the urban economist Gregory K. Ingram (Mohan, 1994).[30]

As noted above, public utilities and the local government in Bogotá have borrowed heavily from some of these international organizations. This has allowed the latter to have an important role in public decisions in the city. Thus, the reliance on external debt and advice has provided international organizations with an opportunity to advance ideological agendas, implement specific public policies, and be involved in the managerial operation of utility companies. For instance, according to Gilbert (1990: 356), "the major service agencies in Bogotá have followed World Bank advice to the letter" by modifying tariff structures to guarantee long-run costs and adopting the scheme of cross-subsidization. In that sense, international organizations have been

[30] It is also important to note that Albert Hirschman, considered one of the fathers of development economics, "derived the crucial insights for his book, *The Strategy of Economic Development* (1958), during a three-year stint in Colombia's National Planning Department" (Mohan, 1994: 6)

instrumental in defining the commercial orientation of Bogotá's utilities, a characteristic that has been an important contributor of the pattern of under-provision of urban services.

Currently, this ideological influence continues with the World Bank pushing the local government for the privatization of the main utility companies. For instance, the former mayor Enrique Penalosa, who is widely credited for achieving Bogotá's transformation and the implementation of its innovative Bus Rapid Transit system *Transmilenio*, commented that he had "many fights with the people from the World Bank, like the most radical union leader, against the privatization of the water company because they heavily push us towards that privatization [which] for many reasons would be a disaster (…) I don't see myself begging on my knees to the 'private water firm' to see if they will bring the service when a new pirate settlement emerges 500 meters above and how much they will charge me for that. Each negotiation would be unmanageable" (Penalosa quoted in Coing, 2005: 141 – 143).

An important consideration, however, is that politicians have conveniently selected the pieces of the advice from international agencies that will be followed according to particular interests. For instance, suggestions supporting the commercial orientation of utility companies were embraced but those advocating for an increase in property taxation were disregarded (Rojas and Gonzalez, 1988).

Politicians

The pattern of under-provision of land with urban services has been functional to politicians in two ways. On the one hand it has allowed them to gain benefits through the collusion with landowners and formal developers. On the other hand it has provided the opportunity to exercise clientelism and patronage through the programs

of legalization and up-grading. The first way has benefited primarily elite politicians reaching out to the wealthy. Bogotá's politics during the 20th century can be characterized as a private affair concentrated in the hands of a few elite families that "built a public sphere tailored to their own needs" (Zambrano, 2007: 81). Bogotá has been characterized as a 'city of the chosen' where a tight class of land entrepreneurs, regardless of partisan or ideological affiliation, dominated the municipal council, the real estate associations, and the boards of the main construction firms (Suarez, 2006).

Among the many examples in Bogotá's history of politicians influencing planning decisions to benefit lands owned by themselves or their families, the case of Mariano Ospina Perez, President of Colombia from 1946 to 1950, is worth mentioning. Ospinas & Co, a company owned by President's family, started to acquire lands outside the urban perimeter beginning in the 1930s. By the time of Ospina's tenure as president, the firm owned hundred of hectares in the northern part of Bogotá that were incorporated and serviced by the mayor Fernando Mazuera Villegas, who was appointed by the President and was himself an important landowner in the city. With reference to this, Robledo (1985: 60) comments that when Ospina appointed Mazuera as mayor, it was not clear if he was acting as the president of Colombia or as the president of Ospinas & Co. Aprile-Gniset (1983: 117) notes that Ospinas & Co. had achieved a very developed "concentration of administrative functions: it has its offices in the Jimenez Avenue, its steward and associate three blocks up at City Hall, and its executive director four blocks up at the Presidential Palace".

The second way, the opportunity to practice clientelism and patronage, has been more beneficial for local politicians reaching out to the poor. These politicians have tried to obtain popular support by influencing utility companies to define investments according to the interests of their constituencies. However, the responsiveness of

utility agencies to politicians' demands has been limited because of the agencies' commercial orientation. The general policy has been that communities have to finance at least 30 percent of the cost of up-grading, so the role of the politicians initially was to provide part of these funds through parliamentary grants (*auxilios parlamentarios*) (Gilbert and Ward, 1985; Gilbert and Ward, 1982).

After a reform in the 1990s that prohibited these grants, the role of politicians has been limited to make promises of 'lobbying' the utility companies. As an example, Gilbert (1998: 92) describes a case in which two councilors in Bogotá promised to bring water to an informal area in exchange for the resident's votes, the truth was that the politicians knew that the area was on the expansion plans of the water company and was going to be serviced in any case.

4.3. CONCLUSION: THE POLITICAL ECONOMY IMPLICATIONS OF THE NO-GROWTH MACHINE AND THE POSSIBILITIES OF CHANGE

In the previous section, I argued that the under-provision of land with urban services is compatible with the incentives of the main stakeholders in the process of production and consumption of the built environment within a context characterized by inequality and poverty. In this sense then, 'no-growth machines' can be considered a 'rational' strategy to respond to the narrowness of the effective demand. The final result is a system of over-discrimination of tariffs financed through cross-subsidies in which utility companies are forced to concentrate services in the higher segments of the demand and only expand their operations to low-income settlements if the extra revenues produced in high-income areas cover the long term costs of the expansion. In contrast, the American 'growth machine' allows the over-expansion of land with

urban services through a system of equal sharing of the cost of utility investments among the users (Logan and Molotch 2007[1985]).

This is not to say that the Bogotá's no-growth machine does not share the belief in urbanization that is characteristic of its American counterpart. On the contrary, the system grows through a rapid renovation of the stock and an informal market of land with no infrastructure. But this type of growth is very different from the one created by 'growth machines' in the United States since the last is based on the expansion of services while the first is based on their under-provision.

The implications of this difference for the process of urbanization are important. In the case of the United States, over-supply of urban services has enabled a process based on sprawl in which new housing is built in the periphery allowing old housing to filter down to lower categories of demand and creating an important source of housing below production costs (O'Flaherty, 1996). However, this over-expansion of urban infrastructures has generated cities with low-densities, more automotive travel, and higher resource consumption.

In the case of Bogotá, under-supply of urban services has created a process of rapid renovation of the formal stock and a growing informality that prevents the consolidation of filtering-down as an alternative for the poor and result in a high-density city. It is important to note that despite its apparent 'rationality' in terms of the incentives of the key stakeholders in the system, the pattern produced by the under-provision of services is socially inefficient. The dynamic of allowing low-income people to build their own accommodations providing services a posteriori not only fails to pass the test of the 'higher and best use' producing inefficient land use patterns but also it is more expensive than a planned urbanization. Indeed, the cost of up-

grading in Bogotá has been estimated at 2.7 times the cost of building the infrastructure ex-ante (Aristizabal and Ortiz, 2002).

Other studies provide similar evidence about the high cost of up-grading, for instance, Cities Alliance (2006) states that the cost of up-grading an informal unit represents 3.5 times the cost trunk service provision for a formal privately produced unit and 3.78 for a unit produced by NGOs. Roda (2000) calculates the cost of intervention per hectare of the up-grading program (*Programa de Desmarginalización*) as about 2.5 the cost of trunk service provision for a formally produced unit.

For this reason, utility companies, operating under their characteristic commercial logic, have required low-income households to cover at least one third of the cost of up-grading through monetary contributions, labor, and land. In a similar way, politicians have been required to pay partially for the extra-cost through transfers from the general budget and parliamentary grants (Gilbert and Ward, 1985, 1982).

In addition, within this system utilities experience heavy losses through contraband and illegal connections. In the 1970s, for instance, water losses were more than 20 percent and by the 1990s the figure had increased to more than 40 percent (Gilbert, 2007, 1990; Zambrano, 2007).

Furthermore, even though the pirate subdivision system offers a housing solution to low-income households, they have to pay high prices for the quality of the housing they are buying. Informal settlements, even when the land occupation has been achieved through invasion, require capital and extra labor to start the process of incremental construction. For these reasons, they are not for the poorest of the poor, in his analysis of Bogotá, Vernez (cited in Doebele, 1977) observes that only 28 percent the lowest income quintile lives in pirate *barrios* and 2 percent in invasions. In

contrast, the ratio of pirate buyers is 72.4 percent for the low-middle income quintile and 70.2 percent for the middle income quintile.

Currently, the Planning Department estimates that the housing deficit in the city is more than 500,000 units and almost 50 percent of low-income households live in rental units mainly in informal areas (Cities Alliance, 2006). The social costs of the pattern of under-provision of urban services are even higher if we consider other negative outcomes of informal settlements such as the urbanization of zones of high risk, discontinuous growth, and spatial segregation.

Thus, as is the case with the American 'growth machines', the results of the 'no-growth' machine are also socially sub-optimal. Creating more efficient alternatives to the pattern of under-provision of urban services entails reversing some of the conditions that make this system so beneficial for some stakeholders. First and most important, it is necessary to finance infrastructure through the valorization that it produces. Second, it is important to discourage speculation through a system of taxation that penalizes the retention of land with urban services. These goals could be achieved by reinforcing the system of property and land taxation. For instance, by shifting the source of funding the provision of services to low-income households from cross-subsidies to property taxation, utility companies could be incentivized to expand infrastructure by creating a mechanism in which the municipality covers the difference between the tariff and the average long term cost of provision. As for the objective of discouraging speculation, a system of differential rates with higher taxes for vacant urbanizable lots will increase the costs of retaining land from the market, increasing the supply of land with urban services. Moreover, this tax will be a good mechanism of redistribution given the high concentration of property in Bogotá.

In fact, the city has already taken steps into this direction by updating the cadastre, defining 13 different tax rates in which vacant land is penalized with the higher tax, enacting innovative mechanisms to tax land value increases produced by public decisions, and implementing a system to recover the cost of infrastructure by charging developers fees and exactions. However, there is still much that can be done. Although the Cadastral Department has updated values for more than 1.2 million properties in the city (out of almost 2 million), a recent study shows that the city is losing 20 percent of the potential revenue from property taxes because big landholders understate property values. This has been possible because of a system of self valuation that allows tax payers to declare the cadastral value of their properties (Uribe and Bejarano, 2008). For instance, in one case a property commercially valued at more than US$5 million was assessed just at US$100.000 for tax purposes (*Personería*, 2005). In general, the fiscal assessment is around 50 percent of the commercial value, and the difference is higher for the most expensive properties in the north (*El Tiempo*, 2008a).

Moreover, the tax rate is relatively low. Despite the use of differential tax rates going from 4 per thousand to 33 per thousand according to different land uses, the actual average rate is very close to the minimum at 6.6 per thousand (Uribe and Bejarano, 2008). For these reasons, property tax revenue is still low, in 2006 it represented only 0.57 percent of the city's Gross Regional Product (my calculations based on data from DANE [2009] and SHD [2007]) a better figure than the 0.34 percent in 1990 but still far away from the revenue in cities in the developed world.

Thus, the city keeps depending on debt and tariffs and most of the increase in expenditure in the last years has been possible because of the privatization and decapitalization of public companies (Gilbert, 2006). Land with urban services is still

scarce and informality continues growing, in 2008 the office of finance control in Bogotá declared that the growth of pirate subdivisions increased 53 percent from 2004 to 2007 adding more than 1,000 hectares of informal settlements to the city (*El Tiempo*, 2008b).

Nevertheless, the mechanisms to overcome the pattern of under-provision of land with urban services are already in place and, with enough political will, could generate positive results in the near future and show all the stakeholders for which the current system is apparently 'rational' that there are more efficient alternatives for each one of them and for the society as a whole.

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CHAPTER 5

WHY FORMAL HOUSING ALTERNATIVES IN DEVELOPING COUNTRIES ARE INSUFFICIENT, INADEQUATE, AND UNAFFORDABLE: A MODEL OF THE PROCESS OF PRODUCTION OF THE BUILT ENVIRONMENT IN BOGOTA, COLOMBIA

ABSTRACT

In this paper, I present a model of the articulations between the formal and informal mechanisms of housing production with the objective to analyze the causes of the rise and persistence of informal settlements in the developing world. The model is based on System Dynamics, a method of simulation that deals with complex systems characterized by dynamic behavior, and is tested using the case of Bogotá, Colombia, a city known by the prevalence of informal housing markets and its rich experience in the implementation of public policies to address informality. The final results and policy experiments show that informality arises from the inadequacy of a system of infrastructure financing based on tariffs and cross-subsidization and from the unintended consequences of classic interventions to deal with this problem such as settlement up-grading and the provision of public housing. A preventive policy based on dismantling these interventions and increasing the supply of land with urban services through a change in the system of infrastructure funding shifting the source of financing from cross-subsidies to property taxation is proven to be a more cost-effective method to mitigate the negative consequences of informality.

5.1. INTRODUCTION

Cities in the developing world lack most of the features of a formal planned urbanization: property titles, public services, and planning permissions. It has been estimated that 64 percent of the housing stock and 85 percent of the growth rate in the housing stock in the Third World is informal (Berner, 2001). In Latin America, for instance, between 25 percent and 60 percent of the population of the main cities was housed in this kind of development by the 1990s (Gilbert, 1998).

In this paper, I study the causes of this massive non-compliance with planning regulations by analyzing why formal mechanisms of housing production and land allocation have been unable to absorb the growing demand in developing countries. To this end, I study the articulation between the formal and informal mechanisms of housing production arguing that the key determinants causing the rise and persistence of informal settlements are the inadequacy of a system of infrastructure financing based on tariffs and cross-subsidization and the same public interventions that have been deployed to solve the problems related to informality.

The analysis is based on a System Dynamics simulation model of the process of housing production in Bogotá, Colombia. System Dynamics offers two advantages for modeling the formal-informal articulation. First, it allows a comprehensive approach because it deals with complex systems characterized by dynamic rather than static behavior, multiple interactions between internal and external elements, nonlinear relations, feedback, history dependence, adaptive agents, and trade-offs. Second, it allows the simultaneous analysis of quantitative and qualitative variables in contexts of little availability of 'hard' data. Moreover, the method has a long tradition of analyzing urban phenomena from the first Urban Dynamics Model proposed by the

founder of the field (Forrester, 1969), to its subsequent adaptations and extensions (Schroeder, Sweeney and Alfeld, 1975; Mass, 1974; Chen, 1972) and to its more recent applications to the analysis of housing and urban public policies (Eskinasi, Rouwette and Vennix, 2009).

Bogotá, Colombia was chosen as a case study because of its historic prevalence of informal real estate markets and its rich experience in the implementation of different interventions to deal with informality. In addition, Bogotá is an interesting case study of informality, because rather than by invasion and squatting, its informal settlements are the product of 'pirate subdivisions'. This type of informal settlements are illegal parcelings of peripheral land sold by the legal owners without planning permission and without basic infrastructure to poor people who build their own houses through the process of self-construction (Doebele, 1977). Currently, this pattern is becoming more common throughout the developing world.

This paper is structured as follows. First, I summarize the model presenting its basic structure highlighting its theoretical and empirical basis and how its main elements are related with Bogotá's historical urban development. I also analyze the main feedback structures identifying their implications. Then, I present the main results of the simulation describing how the different elements of the structure interact to produce the dynamic generated by the model. Next, I report on the results and theoretical consequences of the eight core validation tests of system dynamics models as defined by Forrester and Senge (1980). Four of these tests evaluate model structure (structure and parameter verification, dimensional consistency, and extreme conditions), three tests evaluate model behavior (replication of the reference mode, behavior sensitivity, and behavior anomaly), and the remaining test evaluates both structure and behavior (boundary adequacy). Finally, I provide some conclusions regarding the dynamics of

informality and propose a policy to mitigate the problem showing its cost-effectiveness using the model. In addition, at the end of the dissertation I include an appendix in which I present the complete model structure and describe in a comprehensive way the equations, parameters, and historical data used to operationalize it.

5.2. THE MODEL

The model consists of three components: Housing Demand and Formal Supply; Urban Services Provision and Informal Housing; and Public Policies and Interventions. It covers 100 years from 1938 to 2038. This time framework was chosen for four reasons: first, given the durability of housing its dynamics are better understood over a long term. Second, as I will show subsequently, prior to 1938 informal housing was marginal in Bogotá. Third, using 1938 as initial year is convenient for initializing the model because a comprehensive census took place in Colombia during this year. Fourth, 2038 provides a symbolic milestone for testing the results of policies and interventions for improving the housing conditions in Bogotá because the city will celebrate the 500th anniversary of its foundation during this year.

Housing demand and formal supply

This component describes the requirements of housing. Because the objective of the model is to capture the long term dynamics of the housing system, the demand is determined according to population forces rather than by short term market variations. As shown in Figure 5.1, the demand is categorized in three groups according to housing quality and household income: High-quality Housing (HH), Medium-quality Housing (MH), and Low-quality Housing (LH).

These categories correspond to the stratification levels used by Bogotá's Planning Department (SDP), which, since 1983, has divided the housing stock according to the quality of the housing and its surroundings in 6 strata: strata 1, 2 and 3 considered low-quality and substandard housing; stratum 4 considered middle-quality and standard housing; and strata 5 and 6 considered high-income or premium housing (SDP, 2005). Before 1983, each public utility company used its own criteria to classify the housing stocks and determine the levels of cross-subsidization of public services, a central concept for the model that will be introduced with more detail in the next section. The stratification is commonly used as a proxy for housing demand and household income (LONJA, 2005; Jaramillo, 2004; Molina, 2001).

As explained in detail in the appendix, the proportion of demanders per category (represented in the Figure 5.1 as the variables '% Demand for HH, MH, and LH') was estimated through the evolution of population per stratum in Bogotá. The incidence of low-quality housing is high: an estimated of 87.5 percent of the population in 1938 and a predicted of 89.6 percent in 2038. High-quality housing demanders, in contrast, are a minority going accounting for an estimated of 5 percent to 4.7 percent in the same time period. The main reason for this imbalance is the high degree of inequality in Colombia, a country that presents one of the worst distributions of income in the world. The Gini Coefficient in the seven largest urban areas in Colombia, for instance, was 0.48 in 1964, 0.52 in 1974, 0.48 in 1984 and 0.50 in 1994. In 2004 the Gini in Bogotá was 0.55 (DNP, 2009; Ocampo, 1994). In contrast, the average Gini in cities in the developed world is 0.35 (Mohan, 1994).

The demand for housing in each category is affected positively by population and negatively by household size. Since population has increased considerably in the city going from 335,512 in 1938 to 6,840,116 in 2005, housing need has increased

accordingly: more people means more demand. This tendency has been reinforced by the decrease in household sizes: less people per household means that more accommodations are needed. In effect, in 1964 the average household size was 6.2 persons, by 2005 it had decreased to 3.4 (DANE, 2009; Mohan, 1994).

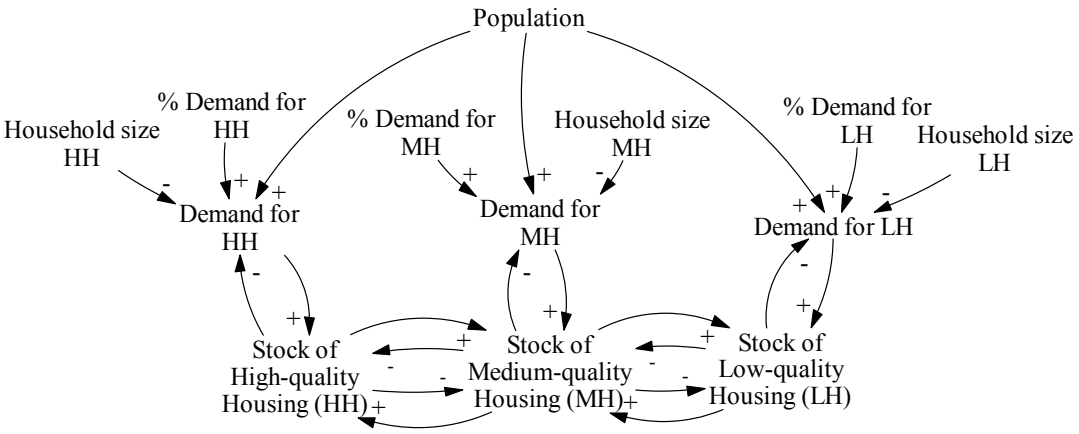

Figure 5.1 Housing Demand and Formal Supply

In the long term the housing stocks are determined by the demand and, as will be explained in the next section, by the capacity of the system to absorb that demand through the production of new housing. The demand and the housing stocks in each category interact through a balancing loop in which more housing demand incentivizes more stock and more stocks decrease the demand for housing by absorbing more households looking for accommodation.

The housing stocks in each category also interact through two sets of balancing loops: filtering and gentrification. Filtering down is the general process by which aged housing is downgraded from a higher to a lower quality level caused when new units displace old ones or when owners fail to invest enough in maintenance to keep the

units at the higher quality level. Gentrification is the particular process by which some housing units are upgraded from a lower to a higher quality level usually caused by a change in location preferences or by a shortage in supply at the higher level. Since filtering and gentrification work in opposite directions, the first increases the stocks in the lower categories and the second increases the stocks in the higher categories, the outcome of this trade-off will depend on specific local factors. As discussed in the appendix, in Bogotá's case both filtering and gentrification are marginal because the tendency is to demolish old high quality units and replace them with new high quality units preventing the consolidation of filtering and making gentrification unnecessary.

Urban services provision and informal housing

The stocks of housing in the long run are not only determined by the demand but also by the capacity of system to generate enough units to absorb the requirements generated by the population dynamics. This capacity is determined by resource constraints. The key limitation to housing production in the developing world is the scarcity of land with urban services. One of the reasons why housing has been called 'the impertinent commodity' is its dependence on urban services such as water, sewerage, electricity, and telecommunications. Since these services require considerable investments and are subject to economies of scale, individual actors are generally unable to reproduce by themselves the necessary conditions for housing production requiring the intervention of centralized collective providers to supply land with these infrastructures (Jaramillo, 1995; Topalov, 1984). The Formal Housing Supply and Informal Housing component describes the process of production of urban services in Bogotá, highlighting the incentives that create scarcity of improved land in the city.

Utility companies in Bogotá have been designed as commercially-oriented and self-sustainable agencies that combine the notion that services should be financed exclusively by their users and the idea that tariffs should be defined according to income in a redistributive fashion (Jaramillo, 1995). This combination has been achieved by means of a system of cross-subsidization in which high-income households pay tariffs that are higher than the average long term cost of service provision to contribute to cover the deficit produced by low-income users who pay tariffs that are considerably lower than the average long term cost.

The structure of the Formal Housing Supply represented in Figure 5.2 shows how the supply of urban services for low-quality housing depends positively on the number of high-quality housing units: more high-quality housing means more cross-subsidies, more services for low-quality housing, and more units in this category. It is important to note that the supply of urban services for low-quality housing is not directly related with the supply of medium-quality housing, this is because tariffs for this last group have been designed to be equal to the average long term cost of provision which means that this category does not subsidize, and is not subsidized by, other categories.

Figure 5.2 also shows two additional sources of services for low-quality housing: cross subsidies from other uses and transferences from the general budget. The first is an important source since commercial and industrial uses pay tariffs that are even higher than the ones paid by high-income households. Moreover, their consumption is also higher and can increase at higher rates; in this model it was assumed that the consumption of these uses grew at the same pace of the GDP in the country (which has been 4.31 in average in the last 50 years [GRECO, 2002]). The second source has been less important since the intent of the cross-subsidization system was to limit financial transfers from the general budget and generate self-sufficient agencies.

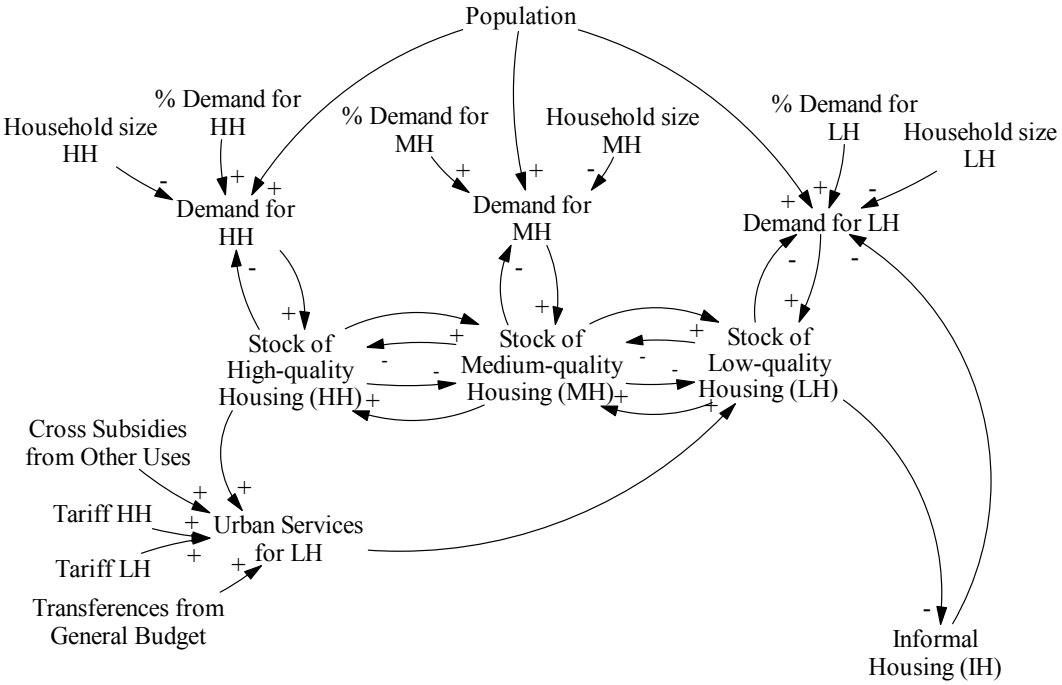

Figure 5.2 Housing Demand, Formal Supply, Urban Services Provision, and Informal Housing

As can be expected, higher tariffs for services in the high-quality category will increase the supply of services for low-quality housing through more cross-subsidization. Also, higher tariffs for the lower category will also mean more supply of services because the subsidy needed per unit is lower and, therefore, the contributions from high-income households will cover more low-quality units. During most of the 20th century the redistributive character of cross-subsidies in Bogotá increased as tariffs for the higher categories grew and tariffs for the lower categories decreased (Gilbert, 2007; Coing, 2005; Mohan, 1994). However, as explained in more detail in the appendix, the pace of growth of the tariffs in the higher category was slower than the pace of the decrease in the lower category. Therefore, the provision of urban services for low-quality housing decreased gradually as the increase in the contributions from the high-quality stock was consumed by higher subsidies per low-quality unit.

In 1994, a new law governing the system of cross-subsidies was enacted. The main objective of Law 142 of 1994 was to improve the efficiency of the provision of urban services in Colombia through privatization and higher competition. To that end, contributions and subsidies were drastically limited by decreasing high-quality housing tariffs and increasing low-quality housing tariffs to levels close to the average long term cost of provision. According to the law, the decrease in contributions from high-quality housing should be gradually covered by the general budget of the municipality through transfers to the utility companies. The problem is that the increase in budgetary transfers has not been sufficient even though some monies have been especially earmarked to this end (Gilbert, 2007). The results of this change have been considered highly regressive since the percentage of income spent on services in low-income households has increased substantially (Coing, 2005). Moreover, the decrease in tariffs for high-quality housing has been almost three times faster than the increase in tariffs for low-quality housing. This means that the supply of services for the lower category is decreasing more rapidly than before.

A key implication of the system of cross-subsidization that has characterized the production of urban services in Bogotá is that utility companies have been incentivized to provide infrastructure without delay for high- and medium-quality developments since, in strictly commercial logic, these consumers will not generate a deficit. Services for low-quality developments, in the other hand, are only provided when the availability of cross subsidies guarantees that the provision for this category is not going to generate deficits. This incentive, added to the fact that the contributions from the high-quality category have been insufficient to cover the demand and have decreased through time, has produced a deficit of urban services that has limited the supply of formal low-quality housing.

Since the growth of the stock of formal low-quality housing has not been able to keep up the pace with the growing demand for units in this category, many low-income households have been pushed to informal housing: self-built accommodations constructed in land with no infrastructure or planning permission.

This component of the model represents the articulation of the stock of formal low-quality housing, the stock of informal housing, and the demand for housing in the lower category through a reinforcing loop: if the formal stock decreases (below what it would otherwise have been) the informal stock increases since more people are pushed to informality. As the informal stock increases the demand for housing decreases since some households find an alternative accommodation, this in turn, decreases the pressure of the demand for more formal units.

Public policies and interventions

Although informal housing has eased the deficit of low-quality units, the results have created many negative outcomes such as substandard housing, sprawl, overcrowding, and marginalization. For these reasons, different public policies have been designed and implemented to decrease the incidence of informality and its effects. Figure 5.3 complements the model structure by including the most important interventions: Up-grading, Demolition and Relocation, Public Housing, and the policy of Minimum Requirements. In the remaining of this section, I will describe in general terms each one of these policies paying particular attention to their costs as they compare to the average long term cost of providing services for a formal unit.

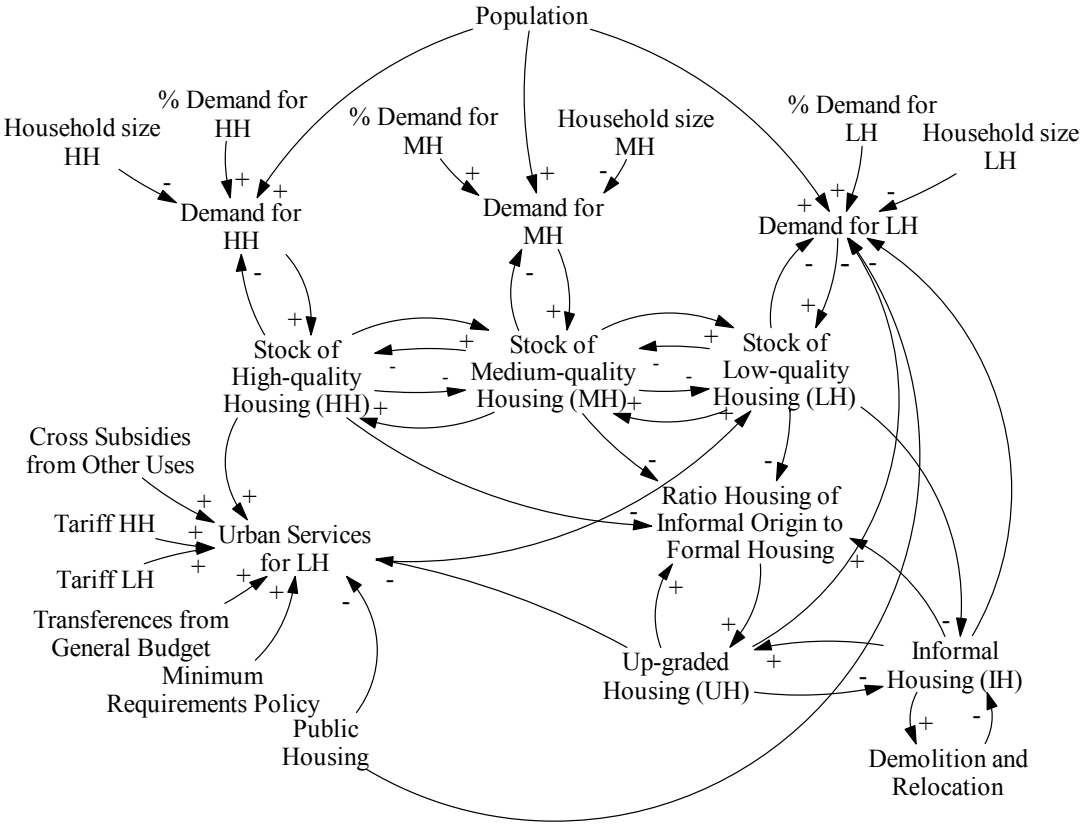

Figure 5.3 Housing Demand, Formal Supply, Urban Services Provision, Informal Housing, and Public Policies and Interventions

Up-grading is the provision of services and infrastructure to informal settlements. As figure 5.3 shows up-grading is represented in the model through the stock of up-graded housing (UH). Since this stock originates from informal housing, it creates a balancing loop where more informal housing creates more up-grading replacing informal units with up-graded units, all other things being equal.

However, up-grading is considerably more expensive than a planned urbanization because it replaces the traditional pattern of site planning - service provision - housing construction - occupation, with the pattern of occupation - housing construction - service provision - site planning (Baróss, 1990).

Because the infrastructure is provided when houses have been already built the cost of up-grading a unit can represent as much as three times the cost of the trunk service provision for a formal unit (Cities Alliance, 2006; Aristizabal and Gomez, 2002; Roda, 2000). For this reason, up-grading creates an important reinforcing loop for informal housing by decreasing the provision of urban services below what it would otherwise have been. This, in turn, decreases the stock of formal low-quality units, increases informal housing, and increases the need for more up-grading.

Although allocating scarce resources to the process of up-grading is more expensive for the municipality, it is, nonetheless, pushed onto the agenda by politicians, informal settlers, and other actors that profit from the system of informality. This social pressure for up-grading is captured in the model by the effect of the ratio of informal housing to total housing. The intuition is that as the proportion of informal housing increases, the pressure to up-grade becomes stronger.

Up-graded housing is also related positively to this effect since it can be expected that as more housing is up-graded, the remaining informal units will push harder for the same treatment. This creates another important loop reinforcing up-grading. It is important to highlight, however, that public utilities in Bogotá have always protected their commercial orientation from political interference requiring politicians and residents to pay partially for the extra-cost through transferences from the general budget and higher tariffs (Gilbert and Ward, 1985, 1982).

Demolition and relocation is an outflow for the stock of informal housing produced by an alternative intervention practiced when it is not possible to up-grade the units. With this policy the municipality gives a payment to the informal settlers recognizing the improvements achieved through the process of self-construction. In some cases the

municipality also offers technical assistance, a subsidy, and access to credit in order to facilitate the process of finding an alternative accommodation in the formal market.

As explained in the appendix, the incidence of this policy is not significant since it is usually only applied with units that are located in zones of high hazard risk. Another important characteristic of this policy is that it is more expensive than up-grading representing up to 5.5 times the cost of providing services through the formal process (Roda, 2000). However, it is important to note that this intervention does not affect the provision of services for low-quality housing since it is funded entirely from the public budget and is operated by the same municipality and not by the utility agencies.

The provision of public housing is a preventative policy intended to provide a formal alternative for low-income households to discourage informal development. More than 150,000 public units have been produced in the city in the last century, with particular intensity in the decades of the 1960s, 1970s, and 1980s when almost 130,000 units were built. In addition, almost 50,000 units have been constructed by the public sector for middle- and high-income strata in particular public employees and members of the army (*Secretaría del Habitat and Universidad Piloto de Colombia*, 2008; ICT, 1997; Saldarriaga, 1996).

In contrast to public housing programs in the developed world, public units in Bogotá have been produced for sale and not for rent. This characteristic has important implications in terms of the demand and in terms of the costs of the policy. Regarding the demand public housing units have always been appropriated by the higher tier of the low-income demand and have not reached the poorest of poor (Mohan, 1994; Gilbert and Ward, 1982). As for the costs, the housing authorities have been able to recover some part of the costs through the sale price. However, the costs related to the

trunk services provision, the secondary (domestic) services provision, the housing subsidy, and written-off debts (which were considerable during the period of maximum production) have not recovered in the majority of the cases (ICT, 1997).

For this reason, the costs of providing a public unit could represent more than 6 times the cost of trunk services provision for a formal unit (Roda, 2000). For utilities the cost is 2.33 times the cost of providing formal housing since it only includes both the trunk and domestic provision. The extra-cost (the difference between 6 and 2.33) is usually covered by the budget of the housing authorities. Since public housing diverts resources, decreasing the supply of services for low-quality formal units below what it would otherwise have been, it affects negatively the availability of services and, therefore, decreases the provision of formal housing as shown in Figure 5.3. But at the same time by providing an alternative for some low-income households it decreases the demand helping to ease the pressure for new low-quality stock.

The policy of minimum requirements was an attempt to increase the formal housing supply by way of relaxing planning standards. The basic idea was to provide lots with a very basic infrastructure to low-income households so they could replicate the pattern of self-construction within a formal and legal framework. The policy was first implemented as a pilot test in public projects financed by the Alliance for Progress in the 1960s and then in large scale for the total production of formal housing in 1972 when a law regulating the minimum requirements was enacted (Saldarriaga, 1996).

At the beginning, the policy provided modest results because the procedures for granting permission to 'minimum requirement developments' were very time consuming and complicated (Mohan, 1994). After additional regulations were enacted in 1979 to promote and facilitate implementation, a considerable portion of the

demand was absorbed through this mechanism (Molina, 1990). However, the results of the minimum requirements policy began to be criticized based on concerns that it was replicating the pattern of substandard housing producing urban environments characterized by extremely high densities and lack of public spaces (Ceballos, 2005). In 1990 the policy started to be watered down and disappeared completely in the new urban plan of 1997.

As shown in figure 5.3 the minimum requirement policy increased the supply of services for low-quality housing because it decreased the average long term cost of provision by allowing the progressive development of infrastructure with lower technical specifications. The actual decrease in the cost of provision is difficult to calculate since the requirements changed over the years but it can be estimated that at its peak the policy could have decreased the average long term cost by as much as 30 percent (see the appendix).

5.3. THE RESULTS

To run the model until the year 2038 it is assumed that all the trends evidenced for the last year with available data (2005 for most variables related to population and 2010 for variables related to policies) maintain the same behavior in the future. In this way, population, which is modeled as an exogenous variable, continues increasing at the present rate reaching more than 11 million for the last year of simulation. Figure 5.4 presents the evolution of the population estimated by the model (Base Run) comparing it with the actual data from census sources (Reference Mode).

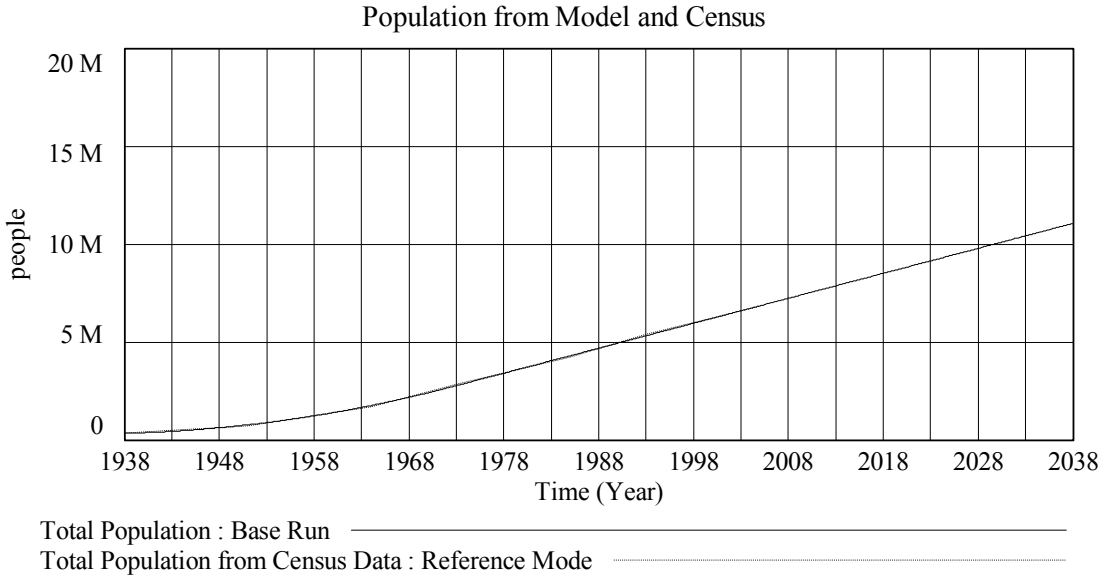

Figure 5.4 Simulated Behavior of Population in Bogotá from 1938 to 2038 from Model and Census Data

The increase in the population produces an increase in every category of the demand including the demand for high-quality housing (HH). Since this category has no restriction in terms of availability of services, the supply increases according to the demand. This increment in high-quality housing is important because, all other things being equal, it will result in more public services for low-quality housing (LH). The degree to which this happens will depend on the relative behavior of the tariffs and in other public policies.

Figure 5.5 shows the services support function, a representation of the number of low-quality units that can be serviced per high-quality unit. This number decreases at the beginning of the study period as the redistributive character of tariffs increases (and the subsidy for each unit in the lower category increases), since fewer units will be supported by the contributions from high-quality units. However, after 1958 it starts to increase because of the extra-support provided by commercial and industrial uses and grows considerably during the 1970s and 1980s due to the decrease in servicing costs

produced by the policy of minimum requirements. During the 1990s the support is affected negatively by the dismantling of this policy and the changes introduced by Law 142 of 1994. After 2010, the year in which is assumed that the tariffs will achieve their targets according to the mentioned law, the support increases again pushed by the increase in consumption of commercial and industrial uses. The services support function is calculated exogenously from data about tariffs and the cost of provision as explained in the appendix.

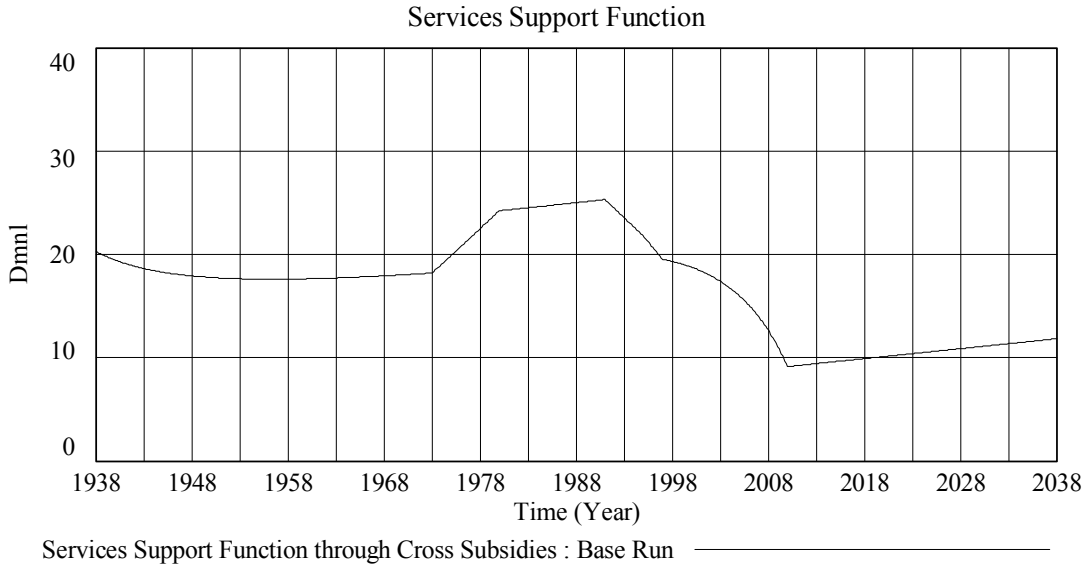

Figure 5.5 Simulated Behavior of the Services Support Function: a representation of the number of low-quality units that can be serviced per high-quality unit**.**

The total number of new low-quality units that can be potentially serviced per year also depends on the transfers from the general budget to the utility companies. As described in the previous section, Law 142 in 1994 increased these funds to compensate for the decrease in the contributions from high-quality housing. In the later years, the percentage of transferences in the budget of the main utilities has reached 50 percent compared to less than 5 percent before the implementation of the

law. Figure 5.6 shows the total number of low-quality units that could be provided with services through funds from cross subsidies and from the general budget. The sum of these numbers, however, is not equal to the effective production of low-quality housing because this support is affected negatively by the production of public housing and the pace of up-grading as these policies drain resources from the utility companies. For this reason the actual feasible production of low-quality housing is lower.

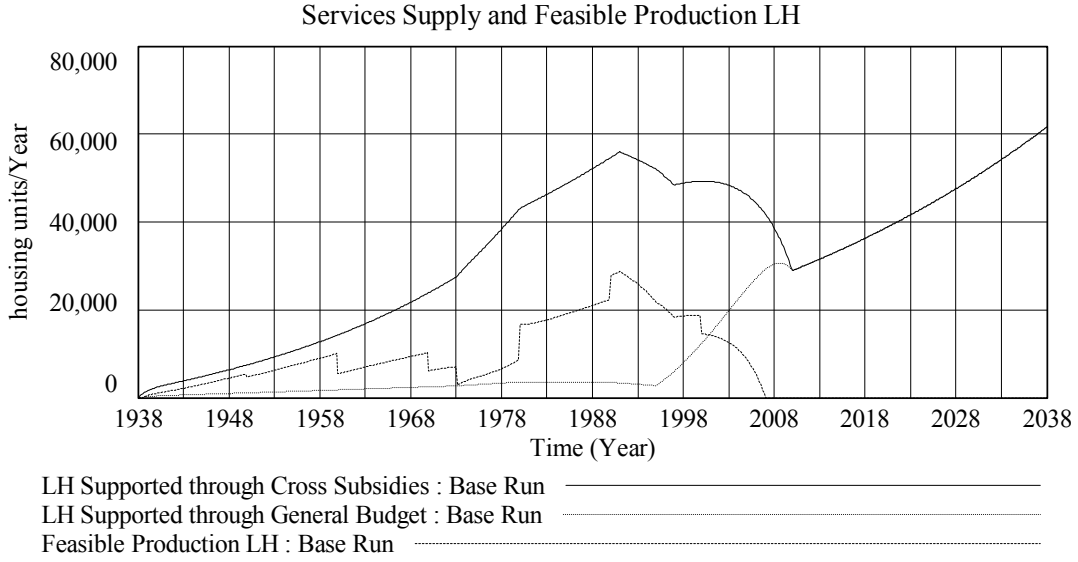

Figure 5.6 Simulated Behavior of Services Supply and Feasible Production of Low-quality Housing

Because public housing and up-grading are more expensive than the provision of a low-quality unit, these policies crowd-out an increasing number of formal housing resulting in a reinforcing effect in which more informal units are produced, more units are up-graded, fewer services are available for low-quality formal production, and more households are pushed to informality. Figure 5.7 shows the behavior of public housing production (an exogenous variable in the model), informalization (an endogenous variable), and up-grading (an endogenous variable). Public housing

production has an uneven pattern because it was estimated by dividing the actual number of public units built per decade into the number of years (no annual information was available). This causes the broken pattern of the feasible production variable in figure 5.6. It is also important to note that the growth of informality decreased during the 1980s due to the minimum requirements policy as some authors have suggested (Molina, 1990). However, the decrease in the services support function, caused by the elimination of this policy and the changes of Law 142 of 1994, produced a considerable increase in the rate of informalization during the 1990s, which resulted in more pressure for up-grading and more crowding-out of services for low-quality formal units. That explains why the feasible production in this category reaches zero around the year 2008 as was shown in figure 5.6.

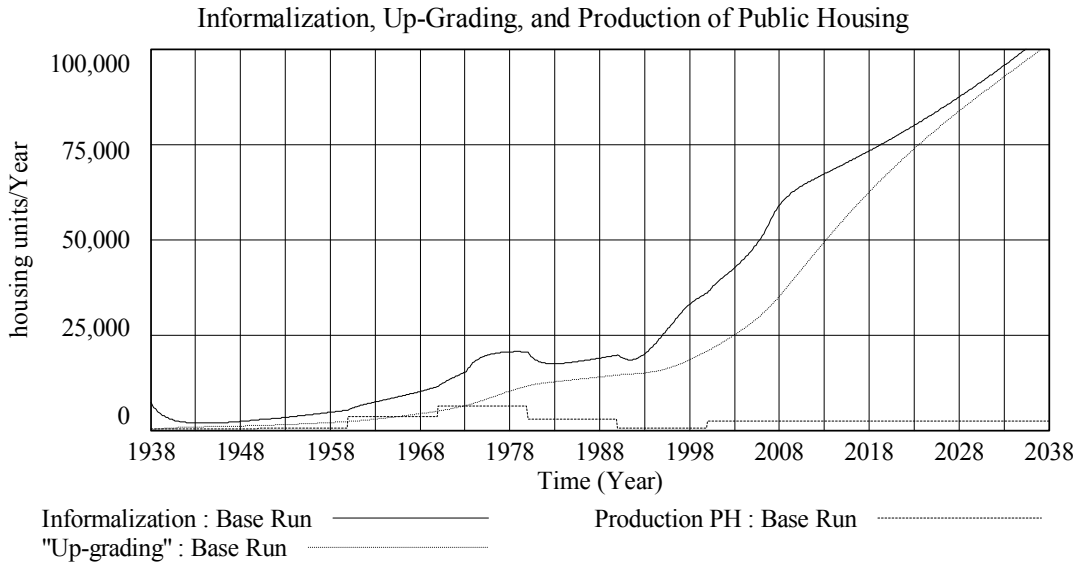

Figure 5.7 Simulated Rates of Informalization, Up-Grading, and Production of Public Housing

The growth of informalization and up-grading results in a rapid increase in the stock of housing of informal origin (defined as the sum of the stocks of informal housing [IH] and up-graded housing [UH]). This trend intensifies in the 1990s to the point that

around the year 2003 these stocks overcome the housing stock of formal origin (the sum of high-quality [HH], medium-quality [MH], low-quality [LH], and public housing [PH]) as the main housing source in the city. Figure 5.8 represents this trend showing that before 2003 the stock of housing of formal origin was bigger than the stock of housing of informal origin and that this difference increased in the 1980s as a result of the decrease in informality produced by the minimum requirements policy. However after the 1990s due to the elimination of this intervention, the changes introduced by Law 142 of 1994, and the increase in up-grading, the situation is reversed with the stock of formal origin hitting a plateau and staying around 1 million units for the rest of the simulation. The stock of informal origin, in contrast, grows exponentially reaching more than 3 million units in the year 2038.

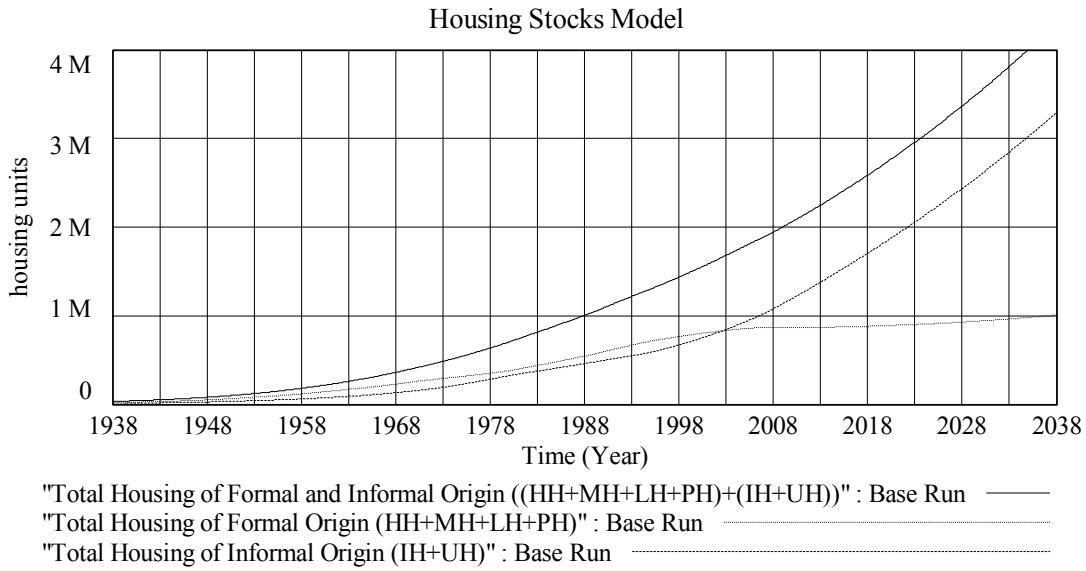

Figure 5.8 Simulated Behavior of Formal and Informal Housing Stocks

The increase in informality eases the pressure of the demand for low-quality housing. As figure 5.9 shows the number of households in this category of the demand increases throughout the period of simulation reaching more than 4 million in 2038

due to the increase in population, the decrease in household size, and the change in the proportion of population demanding this type of accommodation. However, most of this latent demand is absorbed by informal housing reducing the actual demand for formal low-quality housing to around half million.

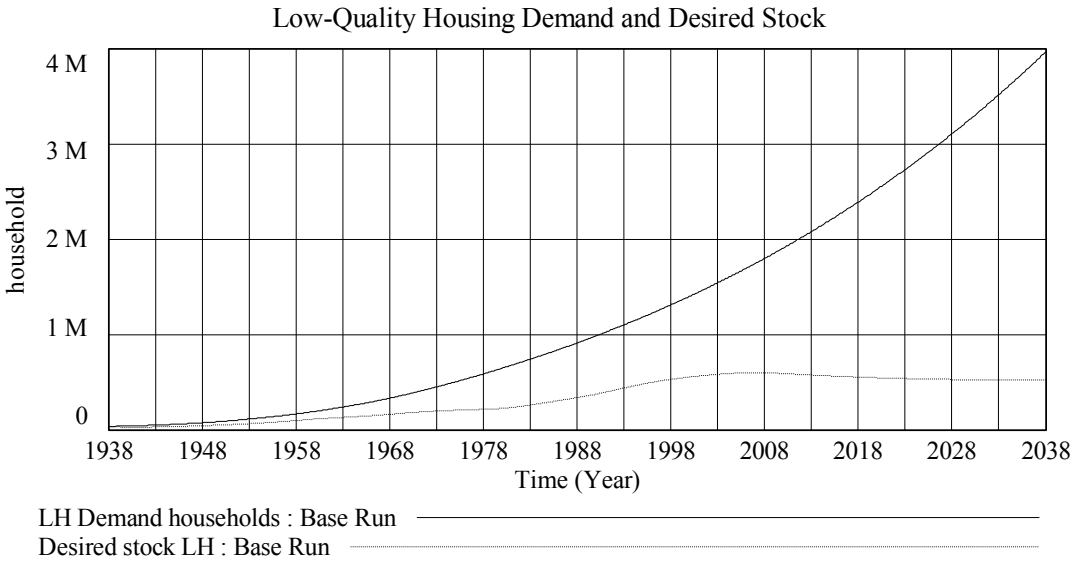

Figure 5.9 Simulated Behavior of Low-Quality Housing Demand and Desired Stock

Nonetheless, as figure 5.10 shows this form of absorbing the increasing housing need is very expensive. In this diagram, the costs of provision of low-quality housing for the public sector (through public budget and cross subsidies) and for low-income households (through tariffs) are represented as the sum of the costs generated by the formal stock, the up-graded stock, and the public housing stock in terms of the number of long term average costs (LTAC) of providing a formal low-quality unit that could have been covered according to the relative costs explained in the last section. These costs increase exponentially, both for the public sector and for low-income households, and their sum, defined as the accumulated total social cost, reaches more than 10 million in 2038. This means that the pattern of absorbing the deficit through

up-grading and public housing is clearly inefficient, since the resources that are allocated to these ends surpass the resources that would have been needed for absorbing the demand through the provision of services for formal housing. In effect, in the long term the 10 million of average costs that the current policies totaled in 2038 would have been more than enough to absorb a demand of 4 million. This inefficiency will be studied with more detail in the next sections.

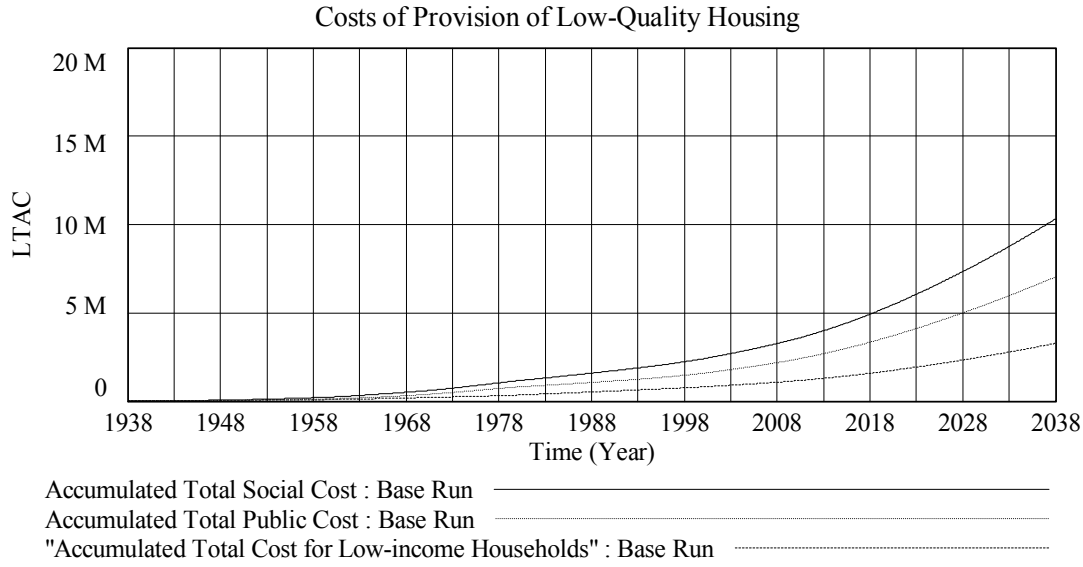

Figure 5.10 Simulated Behavior of Costs of Provision of Low-Quality Housing

5.4. MODEL EVALUATION

Structure and parameter verification, and dimensional consistency

The structure verification test involves comparing the model with the quantitative and qualitative knowledge of the real-world system. The parameter verification test requires that model constants correspond conceptually and numerically to real-world empirical observations (Forrester and Senge, 1980). Hence, these tests require that the

model assumptions do not contradict the accepted understanding of the problem in theoretical and empirical terms. The model described in this paper can be considered robust in both accounts since it was built taking into account all the relevant literature (see the appendix) and its structure represent real-life and tangible variables commonly used in housing analysis. Moreover, as described in the appendix, most parameter values were estimated using available historical data and when this was not possible they were defined using qualitative information supported by the literature and they were tested for sensitivity.

The dimensional consistency test involves evaluating if the units of the variables maintain the coherence throughout the mathematical operations defined in the model's equations (Forrester and Senge, 1980). The model passes this test since no 'scaling' parameters (constants with no real-life meaning) are included in the structure. Moreover, the built-in software tool verifies that units are consistent.

Extreme conditions

This test evaluates the implications for the overall behavior of the model when variables and parameters are changed for improbable maximum and minimum values (Forrester and Senge, 1980; Sterman, 2000). The model is also robust to this test because the simulation of unrealistic conditions produced consistent responses in the dynamics of the system.

Figure 5.11, for instance, shows how the stock of housing of informal origin responds to some extreme conditions. When the services support function for low-quality housing from high-quality units, commercial and industrial uses, and the general budget is set to zero, informality increases, compared to the Base Run, since this and public housing would be the only ways to absorb the demand. When public housing or

up-grading are set to zero, informality decreases since the provision of services in these policies is more expensive than in the case of formal low-quality units. When the percentage of high-quality demanders is set to 20 percent (up from an initial condition averaging 5 percent) and the percentage of low-quality demanders is set to 40 percent (down from an initial condition averaging 87 percent) informality decreases since there is more supply of services for low-quality housing and less demand. When the population is set to zero, the stock of informal origin is zero for the entire simulation since there is not demand for housing in the system.

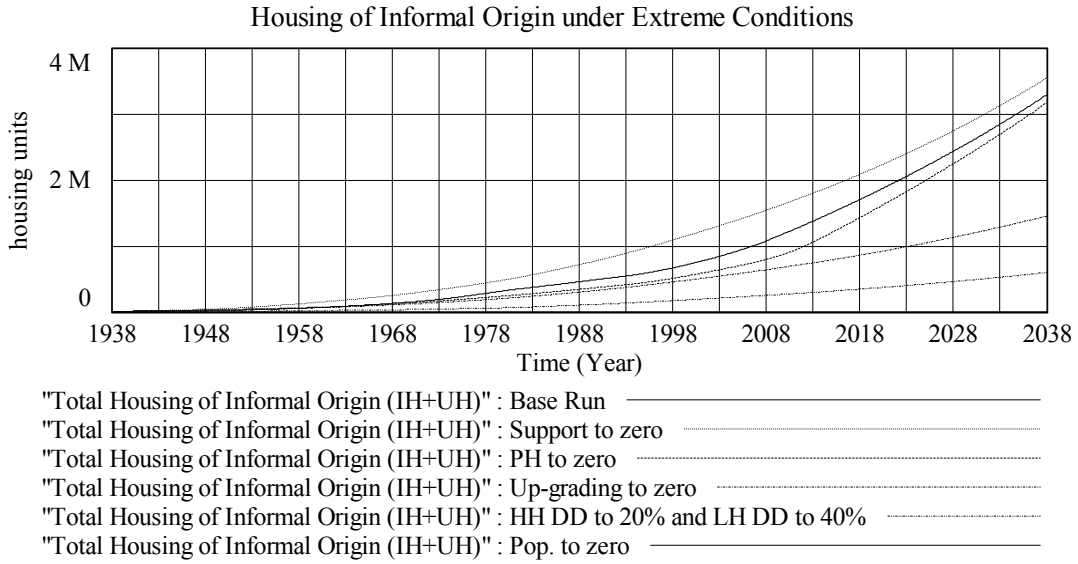

Figure 5.11 Simulation of Extreme Conditions Tests

It is important to note that these tests can work as counterfactual analyses. They show, for instance, that although public housing and up-grading are interventions that clearly aggravate the problem, their elimination does not eliminate informality completely, so, from a policy perspective, their dismantling would have to be complemented with other interventions. Also, the fact that informality is very responsive to the percentage of households per category of the demand shows that a more equitable distribution of

income could have prevented the rise and persistence of informal settlements in the city since more units will generate contributions and less will demand subsidies.

Replication of the reference mode

This test, also known as behavior-reproduction test, entails the comparison of the results of the model with the observed behavior of the real system (Eskinasi, Rouwette and Vennix, 2009; Forrester and Senge, 1980). In this case the main outcome variables, the housing stocks, were compared with real data and estimations produced by other authors. Figure 5.12 shows the total housing stock generated by the model (Base Run) compared to census data (Reference Mode). In general terms, the model replicates the overall behavior although it overestimates housing units and misses the timing of an apparent inflexion point after 1993. The implications of these omissions will be considered at the end of this section.

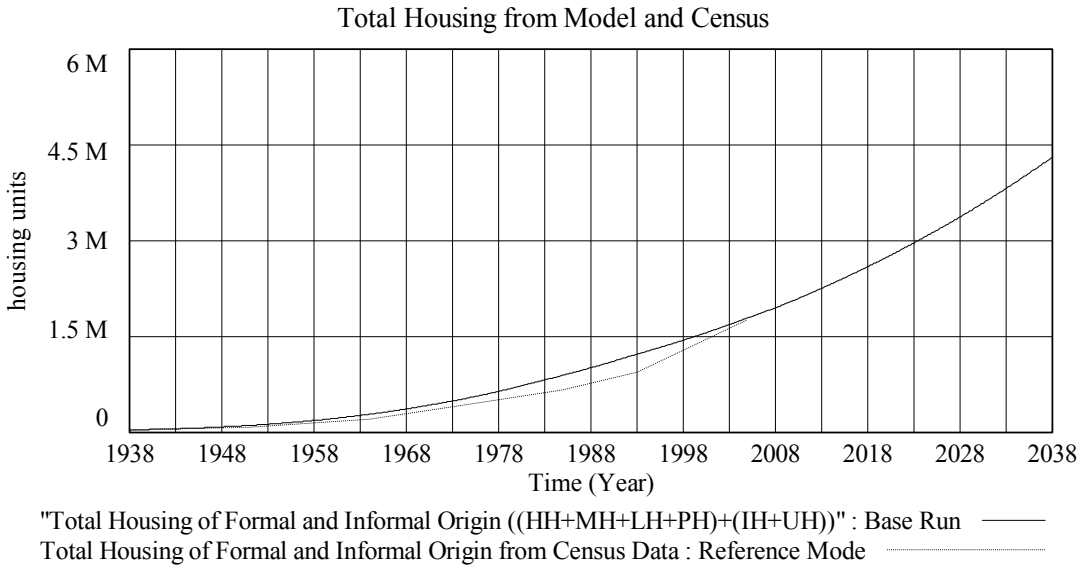

Figure 5.12 Behavioral Reproduction Test: Simulated Total Housing from Model and Census Data

The censuses do not distinguish between formal and informal housing. For that reason a method proposed by Jaramillo (1980) is used to disaggregate the housing stock per category. This method estimates the number of informal units by subtracting the planning permissions granted in intercensal periods from the total stock in each census. Figure 5.13 presents the comparison of the housing stock of informal origin generated by the model (Base Run) with the estimations produced using census data and Jaramillo's method (Reference Mode). As was the case with the total stock the model overestimates the stock, in particular during the 1980s. However, the model reproduces the general behavior although an inflexion in the reference mode after the 1990s is captured by the model with a delay.

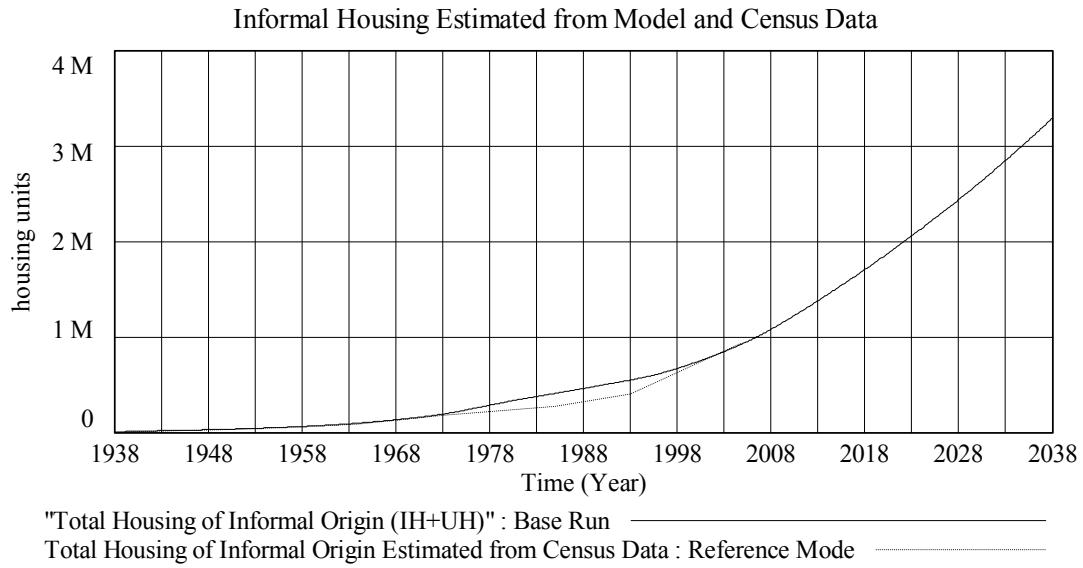

Figure 5.13 Simulated Informal Housing from Model and Census

Figure 5.14 compares the stock of formal housing generated by the model (Base Run) with the estimations produced by census and Jaramillo's method (Reference Mode). Once again the model overestimates the formal stock and presents an inflexion during the 2000s that is not captured by the observed data.

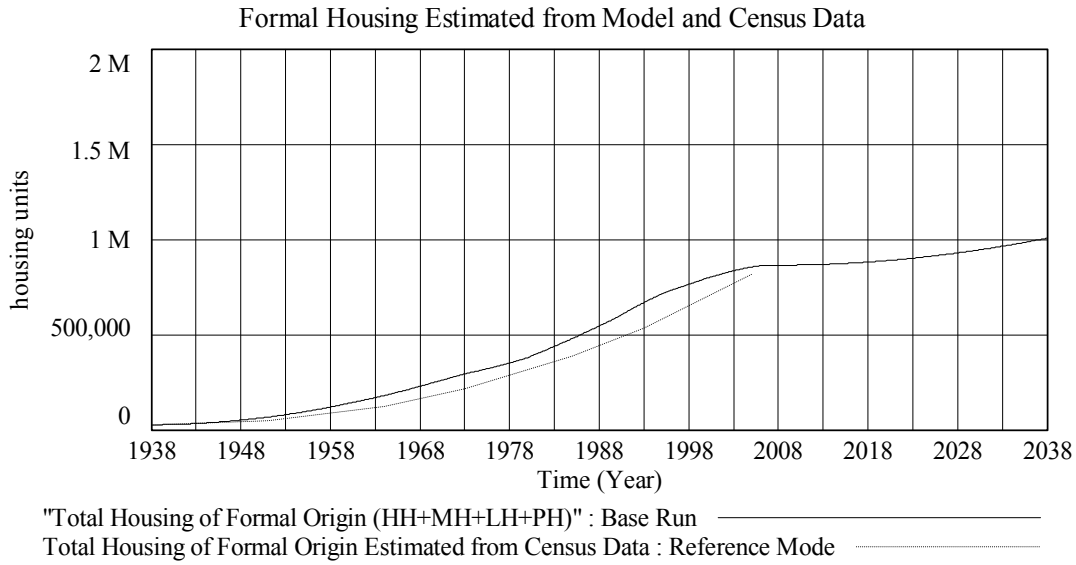

Figure 5.14 Simulated Formal Housing from Model and Census

The differences between the behavior generated by the model and the reference mode could indicate that the structure should be expanded to include more variables of the demand and supply of housing. For example, the overestimation of the total housing stock can be the result of the absence of macroeconomic variables that affect the housing market such as economic growth, interest rates, or inflation. An overestimated housing demand resulting from these omissions could be the reason for the overestimation of the stock of informal origin during the 1980s and the overestimation of the stock of formal origin during the entire comparison period.

However, this can also be related to the absence of variables in the model representing other policies implemented by the national and municipal governments. For instance, a policy of promotion of the commercial building sector, based on financial incentives and mortgage reform, implemented during the period from 1982 to 1986 could be the reason for the decrease in informality in the reference mode during the 1980s.

Likewise, the fact that the reference mode is not showing symptoms of the inflexion in the growth of the formal stock, as simulated in the model during the 2000s, could be related to an extraordinary increase in public investment in infrastructure that was possible thanks to the privatization and decapitalization of public companies. Indeed, some authors have already warned that the expansion of public services achieved in Bogotá in the last years will not be sustainable in the near future (Gilbert, 2006).

Nonetheless, the model can be considered adequate since it complies with the particular behavior-reproduction tests suggested by Forrester and Senge (1980): symptom-generation, frequency-generation and relative-phasing, multiple-mode, and behavior characteristic. First, the model generates endogenously 'the symptom': informal housing. Second, it captures periodicities of fluctuations between variables. Third, it is able to generate more than one mode of behavior when conditions are changed, and the new behaviors are consistent with the logic of the model. Fourth, it shows observed patterns, and this, rather than showing the exact time of the event, is what should be expected in System Dynamics models (Forrester and Senge, 1980).

In particular, the model generates endogenously the important characteristics of the dynamics of the reference mode. First, it simulates that the stock of informal origin overcomes the formal stock during the intercensal period of 1993 and 2005 to become the main source of housing in the city. Second, it estimates consistently the relative weights of formal and the informal housing as percentage of the total stock and this can be a better measure of the appropriateness of a system dynamics model than a point-by-point prediction of the absolute values (Forrester and Senge, 1980). Third, the model accurately estimates endogenously a consistent decrease in the average time for up-grading (the period of time between the initial stages of informal settlement and up-grading) a pattern that has been reported in the relevant literature (*Secretaría del*

Habitat and Universidad Piloto de Colombia, 2008). Table 5.1 shows the behavior of the main variables for the reference mode and the model according to census years.

Table 5.1 Relevant Variables According to Model and Reference Mode

Year	Variable	Reference Mode		Base Run	
		Value	%	Value	%
1938	Population	335,512		335,512	
	Total Housing from Census Data	30,045	100	30,045	100
	Formal Housing Stock Estimated	27,375	91.11	27,375	91.11
	Informal Housing Stock Estimated	2,670	8.89	2,670	8.89
1951	Population	722,100		767,681	
	Total Housing from Census Data	75,559	100	103,846	100
	Formal Housing Stock Estimated	47,195	62.46	67,042	64.56
	Informal Housing Stock Estimated	28,364	37.54	36,804	35.44
1964	Population	1,692,844		1,757,550	
	Total Housing from Census Data	207,055	100	278,167	100
	Formal Housing Stock Estimated	121,802	58.83	180,202	64.78
	Informal Housing Stock Estimated	85,253	41.17	97,965	35.22
1973	Population	2,861,913		2,769,540	
	Total Housing from Census Data	396,856	100	486,974	100
	Formal Housing Stock Estimated	214,614	54.08	294,521	60.48
	Informal Housing Stock Estimated	182,242	45.92	192,453	39.52
1985	Population	4,225,649		4,299,540	
	Total Housing from Census Data	664,135	100	888,873	100
	Formal Housing Stock Estimated	388,750	58.53	479,984	54.00
	Informal Housing Stock Estimated	275,385	41.47	408,889	46.00
1993	Population	5,386,134		5,319,540	
	Total Housing from Census Data	941,286	100	1,217,646	100
	Formal Housing Stock Estimated	534,384	56.77	669,549	54.99
	Informal Housing Stock Estimated	406,902	43.23	548,097	45.01
2005	Population	6,840,116		6,849,540	
	Total Housing from Census Data	1,758,344	100	1,785,339	100
	Formal Housing Stock Estimated	816,382	46.43	855,332	47.91
	Informal Housing Stock Estimated	941,962	53.57	930,007	52.09

Behavior sensitivity*, *behavior anomaly, and boundary adequacy

The behavior sensitivity test evaluates if changes in uncertain parameters cause a failure of the model to replicate the reference mode (Forrester and Senge, 1980). As

stated in the description of the parameter verification test, most of the constants in this model are supported by historical data (see the appendix). However, it was not possible to find reliable data on the rates of filtering, gentrification, and demolition for each housing stock. These values were defined according to qualitative information found in the relevant literature and tested for behavior sensitivity using the built-in optimization and sensitivity tools in the software.

The results of this test show that the behavior of informality is sensitive to this set of parameters and that it is possible to find a combination that reduces substantially the stock of informal housing, all other things being equal. However, the system does that by minimizing the outflows and maximizing the inflows to the stock of low-quality housing to levels that are not plausible in the real world. Moreover, finding a sensitive parameter does not invalidate a model since, in general, "both real systems and models of real systems shown behavior sensitive to a few parameters" (Forrester and Senge, 1980: 223).

The behavior anomaly test examines if the behavior of all the variables in the model, including secondary and auxiliary variables, present incongruencies (Forrester and Senge, 1980). This test is important because it could be possible to replicate the reference mode of the main variables with a model that generates abnormal behavior in the rest of the structure. This is not the case in this model because all the variables correspond to real-life concepts and their behavior present rational dynamics in terms of the information available and the assumptions included.

The boundary adequacy test evaluates if expanding the structure of the model by endogenizing variables alters its behavior (Forrester and Senge, 1980). This test is an iterative process in which the modeler constantly challenges the limits of the model by

adding the necessary structure to include variables and concepts that were previously considered exogenous, or that were not considered at all (Sterman, 2000). In this model the structure was expanded from initial versions to include the internal dynamics of the informal stock, the tariff structure, the policy sector, and the calculation of the costs.

However, there are still some exogenous variables that could be endogenized to enhance the understanding of the system. For instance, the reference mode replication test suggested that it could be useful to complement the structure of housing demand and supply with variables related to the short-term dynamics of the market. Likewise, in the current model public housing is determined exogenously when in reality it should correspond to some perception of public officials about the housing deficit. It is important to note, nonetheless, that none of these expansions would alter the policy conclusions and recommendations produced by the model, a key requirement of the boundary adequacy test as defined by Forrester and Senge (1980).

5.5. CONCLUSIONS AND POLICY RECOMMENDATIONS

The analyses in previous sections suggest several determinants of informal settlements: a growing demand for low-quality housing, a system of provision of public services based on cross-subsidization that cannot keep up with the pace of the demand because of the imbalance of contributions and subsidies, and public policies that aggravate the problem by consuming more scarce resources and crowding-out potential formal units.

Solving the problems associated with informal urbanizations requires addressing these causes directly. In terms of the growing demand for low-quality housing produced by

the rapid pace of urbanization there is not much that can be done in the short term. Although the growth rate of the population in Bogotá has been decreasing in the last decades, the city still receives a considerable number of migrants from rural areas and minor cities.

This phenomenon is more acute in Bogotá than in other Latin American cities not only because of a strong natural growth rate but also because of the armed conflict that has afflicted Colombia during the last 40 years. For instance, during the first semester of 2010 the city received 18 displaced families per day and between 1997 and 2009 the total population arriving to Bogotá in these conditions was 274,376 (El Tiempo, 2010). This population by itself is enough to be considered a large city in the United States.

Moreover, policies to mitigate rural-to-urban migration in Latin America have not been effective as the experience of promotion of growth poles in the 1950s and the 1960s showed. And even in the case that these interventions could actually work their results might not be desirable because they could affect economies of agglomeration and the overall productivity of the economy.

The system of provision of urban services based on cross-subsidization, on the other hand, could be improved through policies to increase contributions and decrease individual subsidies, so more low-quality units could benefit, but these interventions produce unintended consequences. For instance, increasing tariffs for high-quality housing incentivizes utility companies to prioritize the provision of services for this category of the demand and supply low-quality housing only residually. Increasing tariffs for low-quality housing is regressive and could generate an unaffordable burden for low-income households.

A better income distribution that increases the number of households contributing to the system and decreases the number of households receiving subsidies could also solve the problem but is unlikely in the short-term. Other interventions that increase the support of services for low-quality housing through decreasing the average cost of provision such as the minimum requirements policy could be more effective but they affect living conditions condemning lower segments of the demand to inadequate and insufficient public areas and infrastructures.

Dismantling expensive public policies that deteriorate the capacity of the system to provide services for a formal urbanization, such as up-grading and public housing, will contribute to mitigate informality only if the saved resources are actually allocated to generate more formal housing that is affordable and adequate for the needs of the demand.

In summary, a successful policy should incentivize utility companies to provide services to low-quality housing in a way that is both redistributive and financially sustainable. And it should do all of that in the short term. Based on the model presented in this paper I propose a policy that meets all these criteria through two main elements. The first is to change the system of financing services by increasing the amount of individual subsidies to the levels prior to the Law 142 of 1994 and shifting the sources of subsidies from tariffs to property taxation. The second is to change the nature of the policies to deal from informality by dismantling interventions like up-grading and public housing and instituting a policy to provide lots with basic infrastructure ex-ante.

Shifting the sources of subsidies from tariffs to property taxation can incentivize utility companies to expand infrastructure and provide services to low-quality housing

faster because the municipality will cover the difference between the tariff and the average long term cost of provision. This type of arrangement has been successfully implemented in different cases in which there are an interest to increase private supply. For example, housing vouchers designed to promote private housing by covering the difference of what low-income households are willing and able to pay and the market rent have proven to be a more cost-effective system to provide affordable housing in the United States than direct public provision (Newman and Schnare, 1997).

This system of provision of subsidies can also be more progressive than a system of redistribution based on tariffs since the demand for property tends to be more elastic with respect to income than the demand for services (Rojas and Gonzalez, 1998). In effect, according to my own calculations when household income increases from the average for stratum 1 to the average for stratum 6 the consumption of water increases 0.26 for each extra unit of income whereas the consumption of housing, measured by area, increases 0.41. This effect could be stronger if we take into account that the demand for property is less elastic to price than the demand for services and therefore the prices paid in the upper strata tend to be higher than in the lower strata. The progressiveness of a system based on the property tax is even more important in Latin American cities because of their characteristic unequal distribution of land (Uribe and Bejarano, 2008).

Moreover, the resources to fund subsidies generated in this system have the potential to increase quickly in the near future since the revenue from property taxation in Bogotá, as well as in other Latin American cities, is still very low in international terms. For instance the revenue from property tax represented only 0.57 percent of the city's Gross Regional Product (a measure of the size of the economy) when in OECD

countries it represents up to 2.12 percent of the Gross Domestic Product (Uribe and Bejarano, 2008) and in some cities of the United States can reach 4 percent of the Gross Regional Product (Smolka, 2003).

On the other hand, replacing up-grading and public housing interventions with the provision of lots with basic infrastructure will not only prevent the crowding-out effect produced by the higher cost of the traditional policies but also will assure that the solution is adequate and affordable. Indeed, informal settlements have been dubbed as 'architecture that works' because they offer a housing alternative that allows low-income persons to acquire an asset by transforming labor into capital through the process of self-construction (Turner, 1976). Also, informality allows the gradual transformation of physical spaces according to the need of the households expanding accommodations as the family grows or adding more rooms to generate extra income from rental or commercial activities (Abramo, 2007; Gilbert, 1999; Doebele, 1977). The provision of lots with basic infrastructure will allow low-income households to maintain these benefits but avoiding the high costs of settlement up-grading for the municipality.

The basic conditions for this policy are simulated in the model starting in 2010. From this year the tariff for services for low-quality housing is cut in half, the support for urban services from the general budget is increased 3.7 times assuming that property taxation increases up to the level of OECD countries and that this extra revenue is earmarked for public infrastructure. In addition, public housing and up-grading are eliminated. Table 5.2 summarizes the parameter changes for the purposes of policy analysis.

Table 5.2 Summary of Parameter Changes for Policy Analysis

Parameter	Modification in 2010
Tariff for low-quality housing	Multiplied by 0.5
Low-quality Housing supported from general budget	Multiplied by 3.7
Annual Up-grading	Set to zero
Annual Production of Public Housing	Set to zero

Figure 5.15 compares the outcomes of this policy (Policy in 2010) with the projection of the current conditions (Base Run). As represented in the graph the supply of formal housing increases substantially overcoming housing of informal origin in less than 15 years. By 2038 the implementation of the proposed intervention would produce almost 1.5 million formal units more than the current interventions.

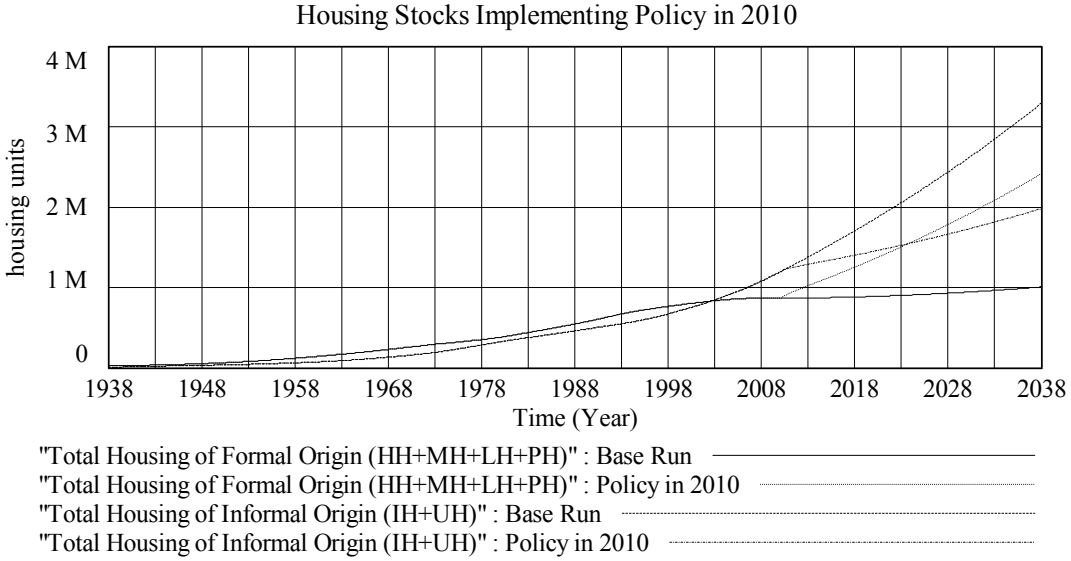

Figure 5.15 Simulated Formal and Informal Housing with Policy in 2010

Moreover this policy will achieve these positive results with fewer resources. The accumulated cost for the public (Accumulated Total Public Cost) through cross-subsidies and the general budget could decrease to almost half of that of the current

policies. The costs for low-income households (Accumulated Total Cost for Low-income Households) also decrease since the tariffs are defined in a more redistributive fashion. Figure 5.16 represents the costs for the public and the costs for low-income households with policy (Policy in 2010) and compares them with the original situation (Base Run).

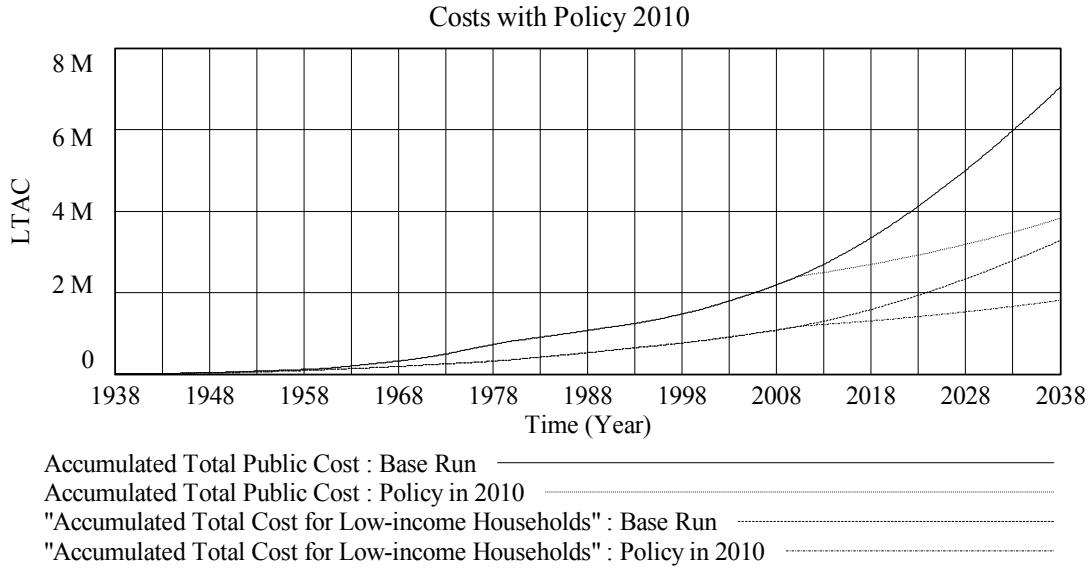

Figure 5.16 Simulated Costs of Low-income Housing Provision with Policy in 2010

These results suggest that it could possible to commemorate the 500th anniversary of Bogotá with a more livable, progressive, and financially sustainable environment. Although the current system has been in the making for decades it is possible to keep its positive characteristics and mitigate its negative incentives with simple measures if there is enough political will to do it. For instance, shifting the sources of funding the provision of services from cross-subsidies to property taxes and replacing policies like up-grading and public housing with the provision of lots with infrastructure are realistic, but effective, interventions that can be implemented in the short term to solve the problems of informality in the city.

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CHAPTER 6

CONCLUSIONS

In this chapter, I summarize the arguments presented so far and analyze the articulation of the findings describing their implications for planning and public policy. In the first chapter, I introduced the central question of this dissertation: why formal mechanisms of housing production and land allocation have been unable to absorb the growing demand in developing countries.

In the second chapter, I provided a justification for this question by describing how the literature on informal settlements has privileged explanations that are more related to the demand side of the question than to the supply side. For that reason, I defined as objective for the following chapters to understand why formal alternatives are scarce, inadequate, and unaffordable.

In the third chapter, I described how a concept of property as a natural right produces a dynamic of privatization of the benefits of city growth and socialization of its costs that results in under-provision of land with urban services and informality. Within this framework, informal settlements are conceptualized as structural to the process of production and allocation and the built environment since they are engendered in the institution of property as a natural right and the power relations that it produces. In this way, I concluded that addressing informality entails not its 'formalization' but a creation of a new type of formality based on a broader notion of property rights.

In the fourth chapter, I analyzed how the pattern of scarcity of land with urban services is produced by a system of infrastructure financing based on tariffs and cross-

subsidization and how this system has produced an outcome that is collectively inefficient but nevertheless apparently 'rational' from the individual perspective of the stakeholders involved in the production and consumption of the urban space. I also studied how the implications of the scarcity of serviced land such as land speculation, the absence of filtering down as an alternative of low-income housing, and policies to address informality such as up-grading and public housing have reinforced the pattern of under-provision of urban services and informality. I concluded by analyzing how a system of financing infrastructure based on property taxation could address the problem of scarcity of serviced land.

In the fifth chapter, I represented the articulations of the formal and informal mechanisms of production and allocation of the built space through a simulation model showing how informal settlements are determined by the pattern of under-provision of urban services and how this pattern is created by the system of financing infrastructure described above and the negative and unintended consequences of up-grading and public housing. I also tested a policy based on shifting the sources of financing infrastructure from cross-subsidies to property taxation and the dismantling of the policies that are reinforcing the system showing how it can decrease informality in the city in the near future.

These arguments can be articulated as follows: a concept of property as a natural right has prevented the consolidation of a system of financing urban services through the valorization that they produce replacing property taxation by a system of cross-subsidization through tariffs that is unable to provide enough infrastructure due to the unequal distribution of income characteristic of Bogotá. This under-provision of serviced land is reinforced by a strong tendency of speculation and the unintended consequences of expensive policies such as public housing and up-grading. In this

sense, it can be concluded that informal settlements are structural to the formal process of production and allocation of the built environment.

The conclusion of this dissertation has important implications in terms of planning since it suggests that a discussion about the reconceptualization of the concept of property rights is necessary if planning is to address the inadequate conditions in which many people is living throughout the cities of the developing world. It can be argued that strengthening property taxation (one of the recommendations of this work) does not require a change in the concept of property rights (another recommendation). However, these two objectives are interrelated and, in the context of an unequal distribution of property as the one described in this document, they should be pursued together because they reinforce each other in a dialectical way. On the one hand, implementing a system of property taxation that recovers to the community the benefits of city growth will help to build a new concept of property that takes into account not only the rights of the owners but also their responsibilities. On the other hand, changing the natural concept of property rights will help to implement a system of financing the infrastructure based on the benefits that it produces.

In addition, this conclusion implies that the discussion about the relative attributes of financing infrastructure through property taxation or tariffs is one that cannot be solved through efficiency arguments alone. It is true that tariffs are easier to collect and that they create market discipline favoring the commercial orientation of utilities and their sustainability. However, as this dissertation suggests, this efficiency also creates incentives to prioritize the provision of services to the demand that is not only 'willing' but also 'able' to pay for them. Since these services are necessary to guarantee basic living conditions, their commodification entails the transformation of citizens into 'consumers' and of rights into 'preferences'.

This is not the same as to advocate for bureaucratic and political mechanisms of provision of urban services. On the contrary, the argument here is that collective decisions about the allocation of these scarce resources should be taken in a public framework and funded in a public way. This dissertation has suggested a policy that combines efficiency in the provision with equity in the allocation which can help to improve living conditions in cities in the developing world. The decision about their implementation only requires political will to defend more the right to the city than an ill-conceived natural and absolute right to property.

APPENDIX A

MODEL OPERATIONALIZATION

The complete model is structured in four sections: Formal Housing Demand and Supply, Urban Services for Low-quality Housing, Public Housing, and Informal Housing. Also, two additional sectors containing auxiliary variables used to generate output information are included: Total Housing of Formal and Informal Origin, and Total Costs of Provision of Low-income Housing. In this appendix, I describe the operationalization of the variables, parameters, and equations included in the model and describe the quantitative and qualitative information used in this process.

A.1 FORMAL HOUSING DEMAND AND SUPPLY

This sector represents the demand for housing according to category (high-, medium-, and low-quality) as a function of population growth and household size and the supply as a function of the available stock. Its structure is represented in Figure A.1 and its equations are operationalized as follows:

Population growth

(1) Total Population= INTEG (New Population, 335512)
Units: people

(2) New Population=(New Population Normal/Average Time for population)+((Population Growth*New Population Normal)/Average Time for population)
Units: people/Year

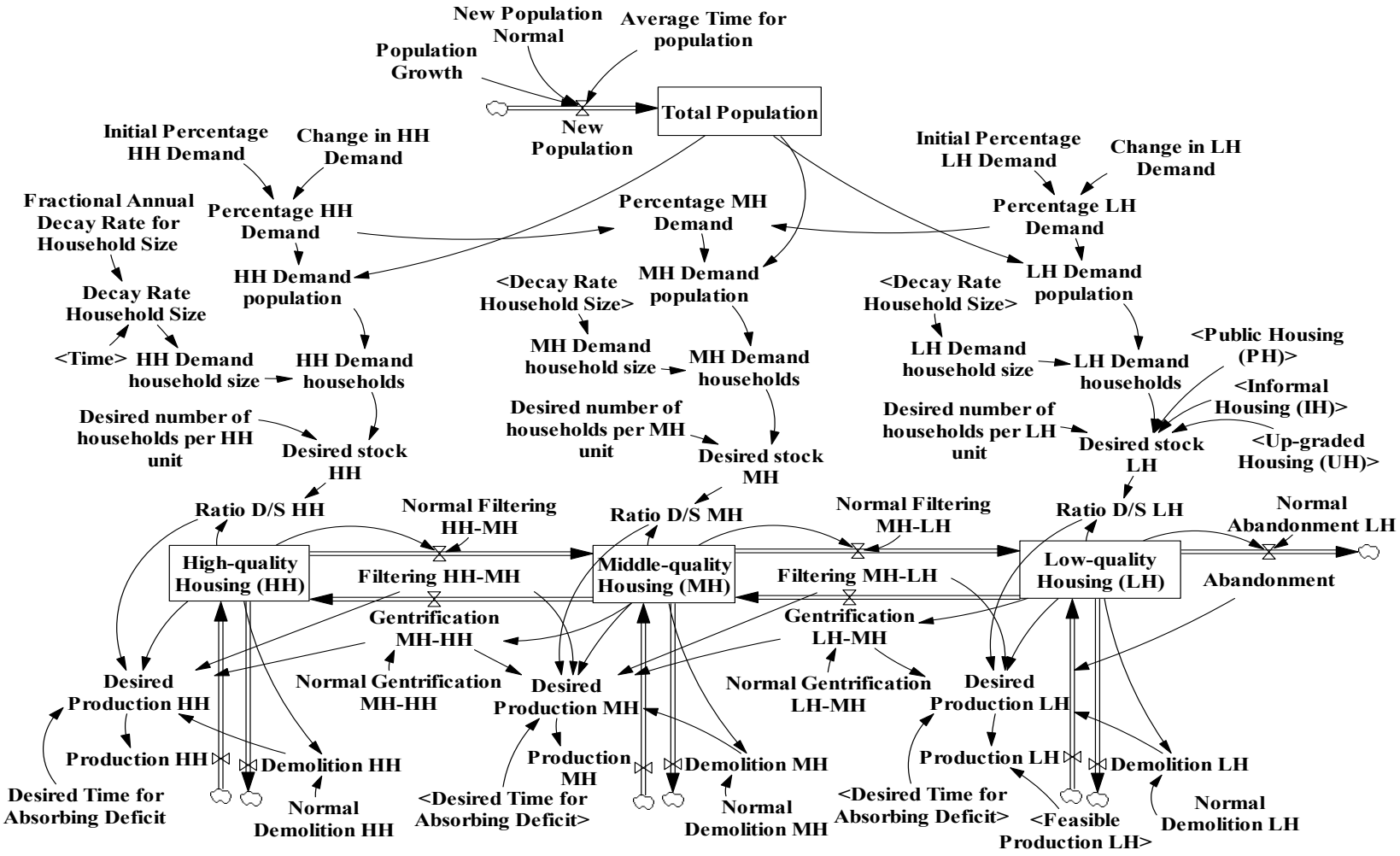


Figure A.1 Formal Housing Demand and Supply Structure

(3) New Population Normal=12000
Units: people

(4) Average Time for population=1
Units: Year

(5) Population Growth=RAMP(0.275, 1938, 1973)
Units: Dmnl

Equation 1 defines Total Population as a stock with initial value of 335,512 which was the population of the city in the census of 1938. Equation 2 represents an inflow to this stock determined by the Normal New Population (Equation 3) which is calculated at 12,000 people per year (Equation 4). Equation 5 defines that this New Population increased at a rate of 0.275 in the period of 1938 to 1973. The values for Equations 4 and 5 were estimated using census data for the years 1905, 1912, 1918, 1928, 1938, 1951, 1964, 1973, 1985, 1993, and 2005. Although this simplified formulation of population growth produces a linear growth for the final years of the simulation, its behavior replicate the historical dynamic as shown in figure 5.4 and since the projected period is relatively short it is not likely to affect the results of the simulation substantially.

Population per category of demand

(6) HH Demand population=Total Population*Percentage HH Demand
Units: people

(7) MH Demand population=Total Population*Percentage MH Demand
Units: people

(8) LH Demand population=Total Population*Percentage LH Demand
Units: people

(9) Percentage HH Demand=Initial Percentage HH Demand+Change in HH Demand
Units: Dmnl

(10) Percentage MH Demand=1-Percentage HH Demand-Percentage LH Demand
Units: Dmnl

(11) Percentage LH Demand=Initial Percentage LH Demand+Change in LH Demand
Units: Dmnl

(12) Initial Percentage HH Demand=0.0501
Units: Dmnl

(13) Initial Percentage LH Demand=0.8757
Units: Dmnl

(14) Change in HH Demand=RAMP(-2.5e-005, 1938, 2038)
Units: Dmnl

(15) Change in LH Demand=RAMP(0.000207, 1938, 2038)
Units: Dmnl

Equations 6 to 8 divide the total population in three categories according to the type of housing demanded. The percentage of Population in the High-quality (HH) Demand category (Equation 9) is assumed to be equal to the percentage of the population in socio-economic strata 5 and 6. The percentage of Population in the Low-quality (LH) Demand category (Equation 11) is assumed to be equal to the percentage of the population in socio-economic strata 1, 2 and 3. The percentage of Population in the Medium- or Middle- quality (MH) category (Equation 10) is assumed as the residual (socio-economic stratum 4).

These strata are defined by the Planning Department since 1983, and by each utility company before that, classifying the population according to income, poverty incidence and the physical characteristics of the neighborhood. The use of strata as a proxy for housing demand or income is fairly common in Colombia (LONJA, 2005; SDP, 2005; Jaramillo, 2004; Molina, 2001) for this model this classification is even more relevant since it determines the levels of cross-subsidization, a central concept in the next sector of the model.

The percentages in each category are assumed to change through time (Equations 12 to 15). This change was estimated by comparing the actual percentages of the stratification in the year 1983 with those in 2005, calculating the linear variation and projecting it for the entire study period. The result is a slow variation with decreases in the HH and MH categories and increase in the LH category. This is congruent with the perception found in the literature about the gradual deterioration of income distribution in the city and in the country. The Gini Coefficient in the seven largest urban areas in Colombia was 0.48 in 1964, 0.52 in 1974, 0.48 in 1984 and 0.50 in 1994. In 2004 the Gini in Bogota was 0.55 (DNP, 2009, *Bogotá cómo vamos*, 2005; Ocampo, 1996). It is important to note that the Gini is not included explicitly in the model because the percentages of population per category were calculated from the percentage of population per stratum.

Household size and households per category of demand

(16) HH Demand households=HH Demand population/HH Demand household size
Units: household

(17) MH Demand households=MH Demand population/MH Demand household size
Units: household

(18) LH Demand households=LH Demand population/LH Demand household size
Units: household

(19) HH Demand household size=7.6*EXP(Decay Rate Household Size)
Units: people/household

(20) MH Demand household size=7.6*EXP(Decay Rate Household Size)
Units: people/household

(21) LH Demand household size=8.3*EXP(Decay Rate Household Size)
Units: people/household

(22) Fractional Annual Decay Rate for Household Size=-0.012
Units: 1/Year

(23) Decay Rate Household Size=Fractional Annual Decay Rate for Household Size*(Time-1938)
Units: Dmnl

Equations 16 to 18 define that the number households per category is equal to the population per category divided by the household size (the average number of persons per household). Equations 19 to 23 state that household size varies according to category and changes through time. Household size has decreased in Bogotá in the last decades. In 1964 the average household size was 6.2 persons per household (Mohan, 1994), in 1973 it was between 5.04 (Molina, 2001) and 5.2 (Mohan, 1994), in 1985 it was 4.92 (Molina, 2001), in 1993 it was 3.92 (Molina, 2001; SDP, 2005), and in 2005 it was 3.4 (DANE, 2009). This change was modeled as an exponential decay function combining these different data points. The best result indicated a decaying rate of -0.012. The variation per category was calculated by comparing the average household size for the city with the average per category according to information of household size per strata for the year 2001. In that year, the average household in strata 5 and 6 size was 3.6, in stratum 4 it was 3.6, and in strata 1 to 3 was 3.94 (SDP, 2005).

Desired stock per category

(24) Desired stock HH=HH Demand households/Desired number of households per HH unit
Units: housing units

(25) Desired stock MH=MH Demand households/Desired number of households per MH unit
Units: housing units

(26) Desired stock LH=(LH Demand households/Desired number of households per LH unit)-"Informal Housing (IH)"-"Up-graded Housing (UH)"-"Public Housing (PH)"
Units: housing units

(27) Desired number of households per HH unit=1
Units: household/housing unit

(28) Desired number of households per LH unit=1
Units: household/housing unit

(29) Desired number of households per MH unit=1
Units: household/housing unit

Equations 24 to 26 define that the desired stock is equal to the number of households per category of the demand divided by desired number of household per unit, which is assumed to be 1 (Equations 27 to 29). That means that the desired stock per category is equal to the stock needed to accommodate all households in the city without generating deficit. For the case of Low-quality Housing the desired stock is also affected by the stocks of Informal Housing (IH), Up-graded Housing (UH), and Public Housing since these stocks absorb part of the demand easing the pressure of the demand for low-quality housing.

Housing stocks

(30) "High-quality Housing (HH)"= INTEG ("Gentrification MH-HH"+Production HH-Demolition HH-"Filtering HH-MH",2211)
Units: housing units

(31) "Middle-quality Housing (MH)"= INTEG ("Filtering HH-MH"+"Gentrification LH-MH"+Production MH-Demolition MH-"Filtering MH-LH"-"Gentrification MH-HH",3275)
Units: housing units

(32) "Low-quality Housing (LH)"= INTEG ("Filtering MH-LH"+Production LH-Abandonment-Demolition LH-"Gentrification LH-MH",21889)
Units: housing units

(33) "Filtering HH-MH"=("High-quality Housing (HH)"/"Normal Filtering HH-MH")
Units: housing units/Year

(34) "Filtering MH-LH"=("Middle-quality Housing (MH)"/"Normal Filtering MH-LH")
Units: housing units/Year

(35) Abandonment=("Low-quality Housing (LH)"/Normal Abandonment LH)
Units: housing units/Year

(36) "Normal Filtering HH-MH"=40
Units: Year

(37) "Normal Filtering MH-LH"=50
Units: Year

(38) Normal Abandonment LH=60
Units: Year

(39) "Gentrification LH-MH"=("Low-quality Housing (LH)"/"Normal Gentrification LH- MH")
Units: housing units/Year

(40) "Gentrification MH-HH"= ("Middle-quality Housing (MH)"/"Normal Gentrification MH-HH")
Units: housing units/Year

(41) "Normal Gentrification LH-MH"=500
Units: Year

(42) "Normal Gentrification MH-HH"=400
Units: Year

(43) Demolition HH=("High-quality Housing (HH)"/Normal Demolition HH)
Units: housing units/Year

(44) Demolition MH=("Middle-quality Housing (MH)"/Normal Demolition MH)
Units: housing units/Year

(45) Demolition LH=("Low-quality Housing (LH)"/Normal Demolition LH)
Units: housing units/Year

(46) Normal Demolition HH=400
Units: Year

(47) Normal Demolition MH=500
Units: Year

(48) Normal Demolition LH=600
Units: Year

Equations 30 to 31 represent the housing supply as the stocks of High-quality (HH), Middle-quality (MH), and Low-quality (LH). This simplifying assumption about a segmented market is fairly common in the literature of Urban Dynamics (see

Schroeder, Sweeney and Alfeld, 1975; Mass, 1974; Forrester, 1969), Neoclassical Urban Economics (see O'Sullivan, 2009; O'Flaherty, 2005; Mills and Hamilton, 1980) and Marxist Urbanism (see Topalov, 1984). The initial value in each stock was calculated by weighting the formal housing stock in 1938 reported by Jaramillo (1980) in each category according to the percentages of demand. This estimation was made under the assumption that there are no deficits in the high- and middle- categories. This is not only because if there was a deficit the higher categories would displace the demand from the lower category due to their higher purchasing power but also because utilities prioritize the provision for high- and middle-housing since these categories cover the average cost of servicing and, in the first case, generate contributions to provide low-quality housing through the system of cross-subsidization.

These stocks are interrelated by two flows: Filtering and Abandonment in one side (equations 33 and 35) and Gentrification in the other side (equations 39 and 40). Filtering is the general process by which aged housing is downgraded from a higher to a lower quality level evidenced in a decrease in the income level of the occupants over time. Since Low-quality Housing is the lower category of the demand, the process of downgrading from this category is called Abandonment. Gentrification is the particular process by which some housing units are upgraded from a lower to a higher quality level usually caused by a change in location preferences or by a shortage in the supply in the higher level. Also, each stock is affected by two flows: Demolition (equations 41 to 43) and Production (equations 56 to 58 described in the next section).

The rate of Filtering from High- to Middle-quality Housing (equation 33), is defined by the ratio of the value of the stock and the Normal Time that a unit spends in the category. In this case, that time is assumed as 40 years (equation 36). A Normal Time

of 40 years means that under 'normal' or average conditions 2.5 percent of the High-income Housing stock is filtered each year. It was not possible to find actual data about this parameter so the assumption was taken from relevant literature: Jaramillo (1980) states that an average life of buildings of 40 years in each market is the standard assumption in these cases. In his model of Urban Dynamics, Forrester (1969) defines the rate of obsolescence as 3 percent for Premium Housing and 2 percent for Worker and Unemployed Housing, which means a normal active life of 33 years in the premium category and 50 years in the other two categories.

The rate of Filtering from Middle- to Low-quality Housing (equations 34 and 37: 2 percent of the stock is filtered each year representing a Normal Time of 50 years) and the rate of Abandonment from Low-quality Housing (equations 35 and 38: 1.6 percent of the stock is filtered each year, or abandoned in this case, representing a Normal Time of 60 years) are assumed higher not only because in these categories the stock will be used more intensively but also because the production of new Middle- and Low-quality Housing adds years to the expected useful life of these units.

The rates of Gentrification (equations 39 to 42) and Demolition (equations 43 to 48) are defined at 10 percent of the Filtering rate in each category. This reflects the assumption that in 'normal' conditions Filtering will be more common than Gentrification or Demolition: if the market is in equilibrium a higher category will prefer new housing produced in its own category over gentrified units. In the other hand, owners will prefer to filter the units over demolition because filtering is cheaper and assures continuity in the income received from the property. That means that in any year in any category for every 10 units that are filtered to a lower category, only 1 is gentrified and 1 is demolished.

Ratio demand/supply and desired production

(49) "Ratio D/S HH"=Desired stock HH/"High-quality Housing (HH)"
Units: Dmnl

(50) "Ratio D/S LH"=Desired stock LH/"Low-quality Housing (LH)"
Units: Dmnl

(51) "Ratio D/S MH"=Desired stock MH/"Middle-quality Housing (MH)"
Units: Dmnl

(52) Desired Production HH=MAX(((("Ratio D/S HH"-1)*"High-quality Housing (HH)")/Desired Time for Absorbing Deficit)+Demolition HH+"Filtering HH-MH"-"Gentrification MH-HH"), 0)
Units: housing units/Year

(53) Desired Production MH=MAX(((("Ratio D/S MH"-1)*"Middle-quality Housing (MH)")/Desired Time for Absorbing Deficit)+Demolition MH+"Filtering MH-LH"+"Gentrification MH-HH"-"Filtering HH-MH" -"Gentrification LH-MH"), 0)
Units: housing units/Year

(54) Desired Production LH=MAX(((("Ratio D/S LH"-1)*"Low-quality Housing (LH)")/Desired Time for Absorbing Deficit)+Abandonment+Demolition LH+"Gentrification LH-MH"-"Filtering MH-LH"), 0)
Units: housing units/Year

(55) Desired Time for Absorbing Deficit=1
Units: Year

(56) Production HH=Desired Production HH
Units: housing units/Year

(57) Production MH=Desired Production MH
Units: housing units/Year

(58) Production LH=MIN(Desired Production LH, Feasible Production LH)
Units: housing units/Year

Equations 49 to 51 capture differences of demand and supply through the calculation of the ratio of these variables. If this ratio is 1, the Desired Stock and the Housing Stock are equal and demand and supply are in equilibrium. If the ratio is more than 1, the Desired Stock is larger than the Housing Stock and there is a shortage of housing

units in the system. And if the ratio is less than 1, the Desired Stock is less than the Housing Stock and there is oversupply of housing.

To achieve equilibrium of demand and supply the system should produce enough units per year to offset the increase in the demand and the net change in the supply. For that reason the annual Desired Production in every category (equations 52 to 54) should cover the difference of demand (Desired Stock) and supply (Housing Stock) in a specific period of time assumed at 1 year (equation 55). Also, it should cover the units lost through Filtering and Demolition minus the units gained through Gentrification. This is because Filtering and Demolition are negatively related to the supply (they decrease the stock in the category), and Gentrification is positively related to the supply (it increases the stock). To avoid a negative Desired Production a control in the inflow is included in the form of a maximum between the simulated value and zero.

Equations 56 to 58 represent the actual production of housing per category. In the case of high- and middle-quality housing the production is equal to the desired production because the provision of public services, which as described in the second sector of the model is assumed to be the main constraint of housing production, is prioritized for these categories due to the system of cross-subsidization. In the case of low-quality housing the production is the minimum of the desired and the feasible according to the availability of urban services.

A.2 URBAN SERVICES FOR LOW-QUALITY HOUSING

This sector represents the process of provision of urban services for low-quality housing describing the system of cross-subsidization. Its structure is represented in Figure A.2 and its equations are operationalized as follows:

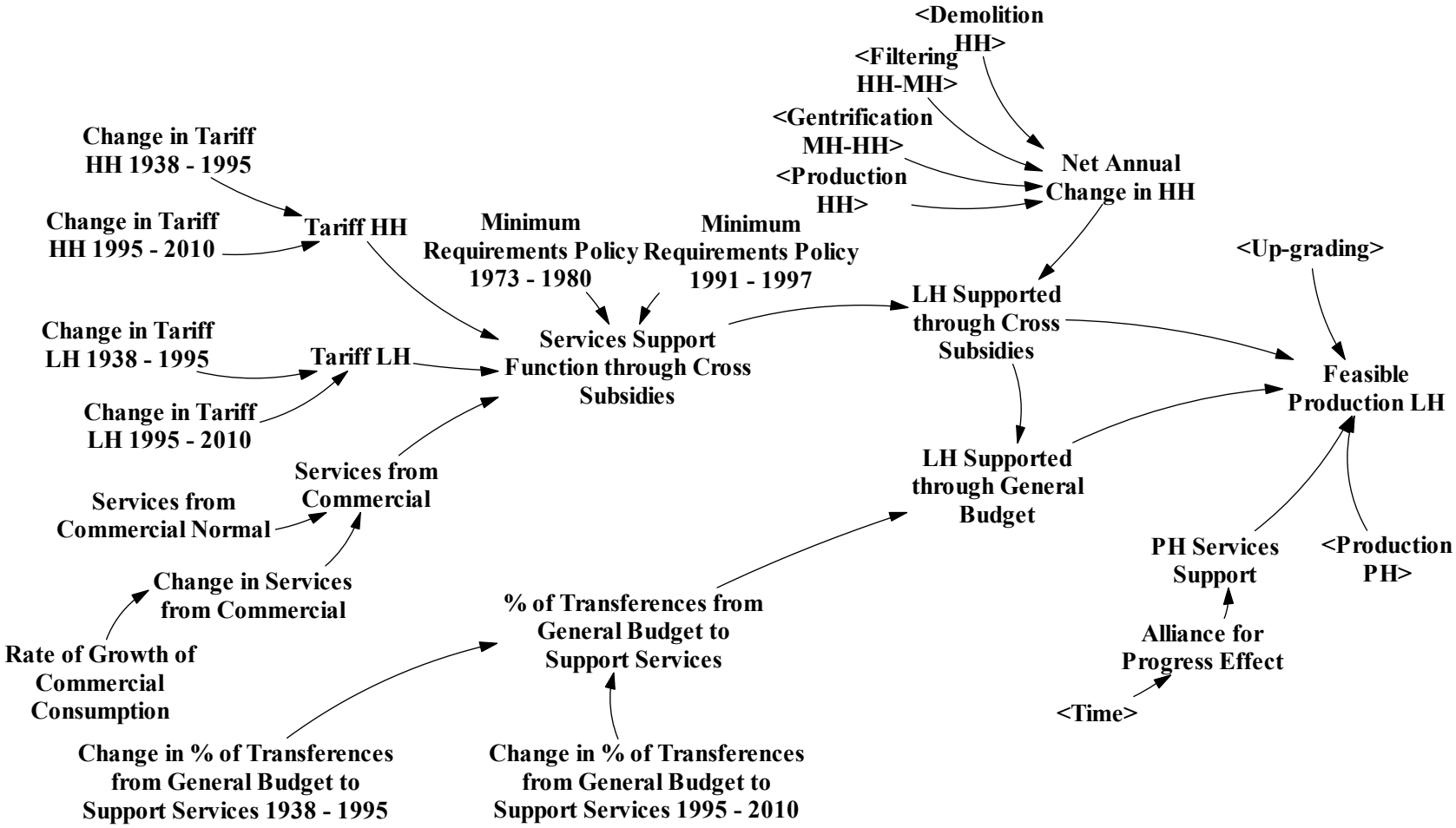


Figure A.2 Urban Services for Low-Quality Housing

Tariffs for high- and low-quality housing

(59) Tariff HH=1.79+"Change in Tariff HH 1938 - 1995"+"Change in Tariff HH 1995 - 2010"
Units: LTAC/housing units

(60) "Change in Tariff HH 1938 - 1995"=RAMP(0.0072, 1938, 1995)
Units: LTAC/housing units

(61) "Change in Tariff HH 1995 - 2010"=RAMP(-0.0667, 1995, 2010)
Units: LTAC/housing units

(62) Tariff LH=0.87+"Change in Tariff LH 1938 - 1995"+"Change in Tariff LH 1995 - 2010"
Units: LTAC/housing units

(63) "Change in Tariff LH 1938 - 1995"=RAMP(-0.01, 1938, 1995)
Units: LTAC/housing units

(64) "Change in Tariff LH 1995 - 2010"=RAMP(0.0267, 1995, 2010)
Units: LTAC/housing units

The provision of public services in Bogotá has been characterized by a system of cross-subsidization in which occupants of high-quality housing pay tariffs that are higher to the long term average cost of provision to finance (or, in the language of the model, 'support') occupants of low-quality housing who pay lower tariffs. Equations 59 to 61 represent the evolution of the tariff per high-quality housing units in terms of the number of long term average cost (LTAC) that it covers. Equation 59 states that this tariff was 1.79 times the long term average cost of provision in 1938 and that from that year it increased linearly at a rate of 0.0072 until 1995 (equation 60) and then it decreased linearly at a rate of -0.0667 until 2010 (equation 61).

These changes (equations 60 and 61) represent the evolution of the system of cross-subsidization characterized by a period of increasing contributions and redistribution from 1938 to 1995 and a change to a system in which tariffs are expected to be as

close as possible to the long term average cost of provision introduced by the Law 142 of 1994. The initial tariff and the rates of change were calculated by following the evolution of the ratio of the tariffs for the higher strata and the medium strata for telephone and telecommunications from the year 1950 to 2010 and projecting the trend linearly to 1938.

Since the system of cross-subsidization has been designed on the assumption that the tariff for the medium strata should be equal to the long term average cost of provision (i.e. this category does not subsidize, and it is not subsidized by, other categories) this ratio could be considered the tariff for high-quality housing in terms of average costs. For instance, a ratio of 1.79 in 1938 means that each housing unit pays the average cost caused by its own provision and contributes and additional 79 percent of the average cost for the provision of low-quality housing.

The service of telecommunications was selected because it provided the longest historical data series of tariffs per strata. The data for the period 1950-2000 was taken from the "Historical Statistics of Bogotá" published by SDP (2000). This information was complemented with data for years after 2000 from other sources (SUI, 2010; SDP, 2005b). To avoid a bias due to the service selected, the resulting ratio was compared to other services such as water and sewerage, electricity, and garbage collection for the years in which the information was available. The results showed that the ratio calculated using only the telephone service was representative of the ratio for the rest of services for the period 1938 to 1995. After 1995, the ratio was similar to that of electricity but lower than the ratio in water and sewerage. This is because this service received a special provision in Law 142 of 1994 that allowed higher tariffs. For that reason, for the years 1995 to 2010 the ratio was corrected using a composite of the tariffs for all services.

Equations 62 to 64 follow the same logic to represent the tariff for low-quality housing in terms of the average long term cost of provision. In this case the ratio is calculated as the tariff for this category compared to the tariff of middle-quality housing. The initial value of 0.87 (equation 62) means that in 1938 each housing unit covered 87 percent of the cost that its provision generated and the rest was financed through cross subsidies. The tariff for low-quality housing decreased at a rate of -0.01 from 1938 to 1995 (equation 63) and then it increased at a rate of 0.0267 until 2010 (equation 64).

Cross-subsidies from other uses

(65) Services from Commercial=Services from Commercial Normal+(Services from Commercial Normal*Change in Services from Commercial)
Units: Dmnl

(66) Services from Commercial Normal=3.34
Units: Dmnl

(67) Change in Services from Commercial=RAMP(Rate of Growth of Commercial Consumption, 1938, 2038)
Units: Dmnl

(68) Rate of Growth of Commercial Consumption=0.0431
Units: 1/Year

Apart from contributions from the high-quality housing, services for low-quality housing are also financed with contributions from the other uses such as commercial, industrial, and official (labeled in figure A.2 just as commercial but including all these different uses in the actual model). Equations 65 to 68 represent this source of contributions as a function of the evolution of the tariff and consumption of these other uses.

Since this support is included in the calculation of cross-subsidies as a multiplier of the contributions generated by high-quality housing (see equation 71 in the next section), it is calculated by comparing the tariffs and consumption for other uses to

those of the higher category (calculating, in effect, the extra-support from other services per unit of support from high-quality housing).

The 'normal' extra-support (equation 66) was calculated as the ratio of the tariff for other uses to the tariff of high-quality housing (1.67) multiplied by the ratio of consumption in these two categories (2) estimated according to data from SDP (2000). This extra-support is assumed to increase for the entire period of the simulation at the rate of growth of commercial consumption (equation 67). This rate is assumed to be equal to the rate of economic growth, calculated as the real average rate of economic growth for 1960 – 2005 as reported by GRECO (2002), since the consumption in these uses depend on the evolution of the economic output (equation 68).

Minimum requirements and services support function

(69) Services Support Function through Cross Subsidies=((Tariff HH-1)/(1-Tariff LH)*Services from Commercial)+("Minimum Requirements Policy 1973 - 1980"*((Tariff HH-1)/(1-Tariff LH))*Services from Commercial)+("Minimum Requirements Policy 1991 - 1997"*((Tariff HH-1)/(1-Tariff LH))*Services from Commercial)
Units: Dmnl

(70) "Minimum Requirements Policy 1973 - 1980"=RAMP(0.0428, 1973, 1980)
Units: Dmnl

(71) "Minimum Requirements Policy 1991 - 1997"=RAMP(-0.05, 1991, 1997)
Units: Dmnl

Equations 69 to 71 define the Services Support Function through Cross Subsidies, a representation of the number of low-quality units that can be serviced per high-quality unit, as a function of the relation of the tariffs, the extra-support from other uses, and the policy of minimum requirements. The first part of equation 69 defines that the number of low-quality units supported depends on the ratio of the contribution from high-quality housing in terms of long term average cost of service provision (which is

equal to the tariff minus 1) and the amount of subsidy per low-quality unit (which is equal to 1 minus the tariff). This ratio is then multiplied by the extra-support from other uses to define the 'normal' total support.

The second part of the equation shows the effect of the minimum requirements policy by representing its impact in the long term average cost of service provision. This impact was calculated by comparing the proportion of the costs of provision of trunk services to that of total services (including trunk and domestic) in a minimum requirement development (estimated using information from Mohan [1994] at 0.29 percent) and the same proportion in a traditional development (estimated using information from Roda [2000] at 0.42 percent). Since the proportion in the case of minimum requirements is about 70 percent that of a traditional development, it can be inferred that this policy decreased the average long term cost of service provision by 30 percent and, therefore, it increased the support in the same proportion since the amount of subsidy per low-quality unit decreased. However, it was assumed that this change did not happen immediately after the law was enacted in 1972 because the implementation of the policy during the first years was very slow and it required another complementing law in 1979 (Ceballos, 2005; Mohan 1994). Likewise, the dismantling of the policy was also a gradual process that started in 1990 and was completed in 1997 (Ceballos, 2005). Equations 70 and 71 capture the gradual implementation and dismantling of the policy of minimum requirements.

Low-quality housing supported by cross-subsidies

(72) LH Supported through Cross Subsidies=Services Support Function through Cross Subsidies*Net Annual Change in HH
Units: housing units/Year

(73) Net Annual Change in HH=Production HH+"Gentrification MH-HH"-"Filtering HH-MH"-Demolition HH
Units: housing units/Year

Equations 72 to 73 calculate the total number of low-quality housing units supported in a given year by cross-subsidies as the support per high-quality unit times the net annual change of the number of high-quality units.

Low-quality housing supported by general budget

(74) "% of Transferences from General Budget to Support Services"=0.15+"Change in % of Transferences from General Budget to Support Services 1938 - 1995" +"Change in % of Transferences from General Budget to Support Services 1995 - 2010"
Units: Dmnl

(75) "Change in % of Transferences from General Budget to Support Services 1938 - 1995"=RAMP(-0.00175, 1938, 1995)
Units: Dmnl

(76) "Change in % of Transferences from General Budget to Support Services 1995 - 2010"=RAMP(0.03, 1995, 2010)
Units: Dmnl

(77) LH Supported through General Budget=MAX((("% of Transferences from General Budget to Support Services"/(1-"% of Transferences from General Budget to Support Services")*LH Supported through Cross Subsidies)), 0)
Units: housing units/Year

Equations 74 to 77 represent another source of funding to support the provision of services for low-quality housing: the transferences from the general budget. Equations 74 to 76 capture the historical evolution of the proportion of transferences to the total revenue of utility companies in Bogotá. This estimation was made using information of the total budget of the Water Company in Bogotá obtained from Jaramillo (1988) for the period before 1985 and from SHD (2010) for the period after 1995. The data for the years in which no information found was estimated according to the trends. The general pattern shows that the proportion of these transferences decreased from 15 percent of the total revenue in 1938 to 5 percent in 1995 (equation 75) and then increased to 50 percent in 2010 (equation 76). This last value is realistic considering

that the transferences from the general budget to the Water Company reached 47.52 percent of the current revenues in 2007. The historical trend follows the logic of the system of financing of public services in Colombia which historically was supposed to be self-sustainable through cross-subsidization without substantial help from the general budget. This changed in 1994 when Law 142 stated that tariffs should be close to the long term average cost and that any deficit produced by subsidization should be covered with resources of the general budget (Gilbert, 2007).

Equation 77 calculates the 'extra-support' achieved through these resources of the general budget in terms of the number of additional housing units per year that can be provided with services. It is important to note that extra-resources in the utility companies' budgets produced by capital resources were not taken into account in this estimation because, in any case, these credits need to be repaid with revenue from tariffs or transferences in a period of 20 years or less (which is shorter than the period of simulation). For instance, Jaramillo (1988) provides evidence that an increase in credit during the 1970s was balanced with an increase in tariffs in 1980s showing that in the long term the capacity of servicing depends only on the revenues generated by utility companies and the transferences from the general budget.

Feasible production of low-quality housing

(78) Feasible Production LH=MAX(LH Supported through Cross Subsidies+LH Supported through General Budget-(2*"Up-grading")-(PH Services Support*Production PH), 0)
Units: housing units/Year

(79) PH Services Support=2.33*Alliance for Progress Effect
Units: Dmnl

(80) Alliance for Progress Effect=IF THEN ELSE (Time>=1960:AND:Time<=1973, 0.7, 1)
Units: Dmnl

Equation 78 defines the Feasible Production of Low-quality Housing per year as the number of units supported by cross subsidies and general budget minus the number of up-graded units and the public units produced in the same period. This is because up-grading and public housing provision consume resources from the utility companies displacing low-quality units. Since these two policies are more expensive, then, each up-graded and public unit will crowd-out more than one low-quality unit.

In the case of up-grading this number is estimated as 2 because according to different sources the cost of up-grading in Bogotá is about 3 times more expensive than a planned urbanization[31] (Cities Alliance 2006; Aristizabal and Gomez, 2002; Roda, 2000) but usually the community is asked to pay at least a third part of these costs through monetary contributions, labor, and land (Gilbert and Ward, 1985, 1982).

In the case of public housing the number of crowded-out units is estimated in 2.33 (equation 79) because the utilities have to provide not only the trunk service but also the secondary or domestic connection, which in the case of private development according to Colombian law is covered by the developer. This represents an extra cost over the trunk service provision of 133 percent per unit for a ratio of 1 to 2.33 (Roda, 2000). It is important to note that other costs of public housing provision such as housing subsidies and written-off debts are not included in this calculation because they are paid from the budget of the housing authorities and not by public utilities. The cost of provision of public housing decreased during the 1960s (equation 80) thanks to a policy implemented by the Alliance of Progress that tested, as a pilot case, the main

[31] In effect, according to the information of Cities Alliance (2006) the cost of up-grading an informal unit represents 3.5 times the cost trunk service provision for a formal privately produced unit and 3.78 for a unit produced by NGO's. Aristizabal and Ortiz (2002) estimate that the cost of up-grading per square meter is 2.7 times the cost of servicing a square meter of a formal development. Roda (2000) calculates that the cost of intervention per hectare of the up-grading program (*Programa de Desmarginalización*) is about 2.5 the cost of trunk service provision for a formally produced unit.

features of the minimum requirement policy that was going to be implemented at large scale in the 1970s.

Equation 78 includes a control that prevents the Feasible Production from becoming negative. This does not state that up-grading and public housing cannot be higher than the support of services for low-quality units produced by cross-subsidies and the general budget. Rather, it defines that utilities will cover the cost of provision of services through up-grading and public housing until it is viable for the companies without generating deficit. From that point on, the cost will be covered by the general budget.

This is consistent with the role of the public utilities in Bogotá since they have always protected their commercial orientation and their financial sustainability requiring politicians and residents to cover part of the cost of up-grading (Gilbert and Ward, 1985, 1982). The up-graded and publicly provided units that are not covered by the utilities through their own revenues will appear later as a cost for the general budget in the last sector of the model since there the total costs of provision of services for low-quality housing are consolidated. The description of the last sector at the end of this appendix includes detailed information on the costs of different interventions.

A.3 PUBLIC HOUSING

This sector represents the evolution of the provision of public housing in the city. Its structure is represented in Figure A.3 and its equations are operationalized as follows:

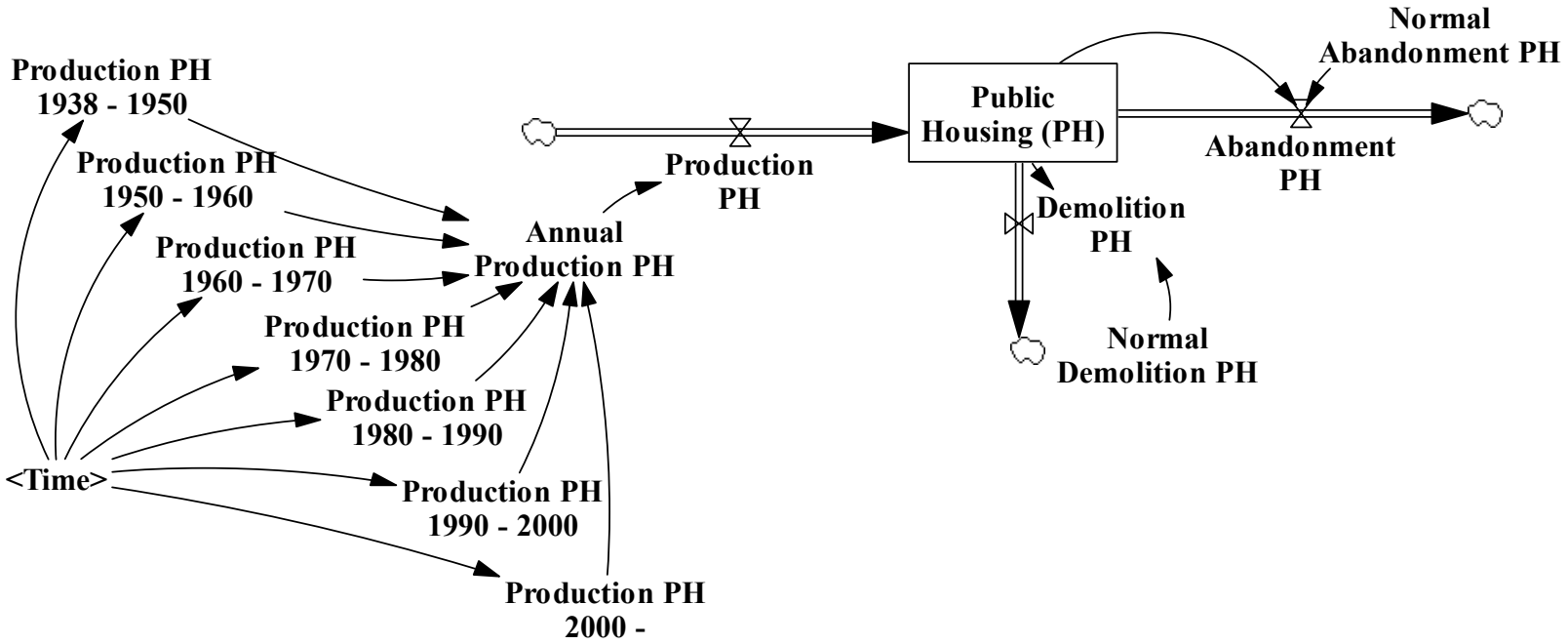


Figure A.3 Public Housing

Annual public housing production

(81) Annual Production PH="Production PH 1938 - 1950"+"Production PH 1950 - 1960"+"Production PH 1960 - 1970"+"Production PH 1970 - 1980" +"Production PH 1980 - 1990"+"Production PH 1990 - 2000"+"Production PH 2000 -"
Units: housing units/Year

(82) "Production PH 1938 - 1950"=IF THEN ELSE(Time<1950, 264, 0)
Units: housing units/Year

(83) "Production PH 1950 - 1960"=IF THEN ELSE(Time>=1950:AND:Time<1960, 581, 0)
Units: housing units/Year

(84) "Production PH 1960 - 1970"=IF THEN ELSE(Time>=1960:AND:Time<1970, 3696, 0)
Units: housing units/Year

(85) "Production PH 1970 - 1980"=IF THEN ELSE(Time>=1970:AND:Time<1980, 6262, 0)
Units: housing units/Year

(86) "Production PH 1980 - 1990"=IF THEN ELSE(Time>=1980:AND:Time<1990, 2860, 0)
Units: housing units/Year

(87) "Production PH 1990 - 2000"=IF THEN ELSE(Time>=1990:AND:Time<2000, 539, 0)
Units: housing units/Year

(88) "Production PH 2000 -"=IF THEN ELSE(Time>=2000, 2372, 0)
Units: housing units/Year

Equations 81 to 88 represent the evolution of public housing in Bogotá. This inflow was estimated aggregating historical data from a variety of sources (*Secretaría del Habitat and Universidad Piloto de Colombia*, 2008; ICT, 1997; Saldarriaga, 1996). Since it was not possible to find annual data, the production per decade for the different public housing authorities was calculated and, then, the annual average was computed. In this calculation, I included the production of ICT (*Instituto de Credito*

Territorial), CVP (*Caja de la Vivienda Popular*), and METROVIVIENDA. Other public offices involved in the production of housing such as FAVIDI (*Fondo de Vivienda Distrital*), CVM (*Caja de la Vivienda Militar*), FNA (*Fondo Nacional del Ahorro*) and BCH (*Banco Nacional Hipotecario*), were not considered in this estimation because they were oriented to middle- and high-quality housing since they produced units for public employees and members of the army. Table A1 summarizes the information related to the production of public housing in Bogotá.

Table A.1 Public Housing in Bogotá 1938 - 2005

Period	ICT	CVP	Metro-vivienda	Total per decade	Annual Average
1938-1950	2,098	1,074		3,172	264
1950-1960	5,776	30		5,806	581
1960-1970	34,389	2,567		36,956	3,696
1970-1980	52,337	10,283		62,620	6,262
1980-1990	23,214	5,387		28,602	2,860
1990-2000		5,387		5,387	539
2000-2005		2,694	9,167	11,860	2,372
Total per Housing Authority	**117,814**	**27,423**	**9,167**	**154,403**	**2,305**

Sources: *Secretaría del Habitat and Universidad Piloto de Colombia*, 2008; ICT, 1997; Saldarriaga, 1996

Public housing stock

(89) "Public Housing (PH)"= INTEG (Production PH-Abandonment PH-Demolition PH,0)
Units: housing units

(90) Production PH=Annual Production PH
Units: housing units/Year

(91) Demolition PH="Public Housing (PH)"/Normal Demolition PH
Units: housing units/Year

(92) Normal Demolition PH=600
Units: Year

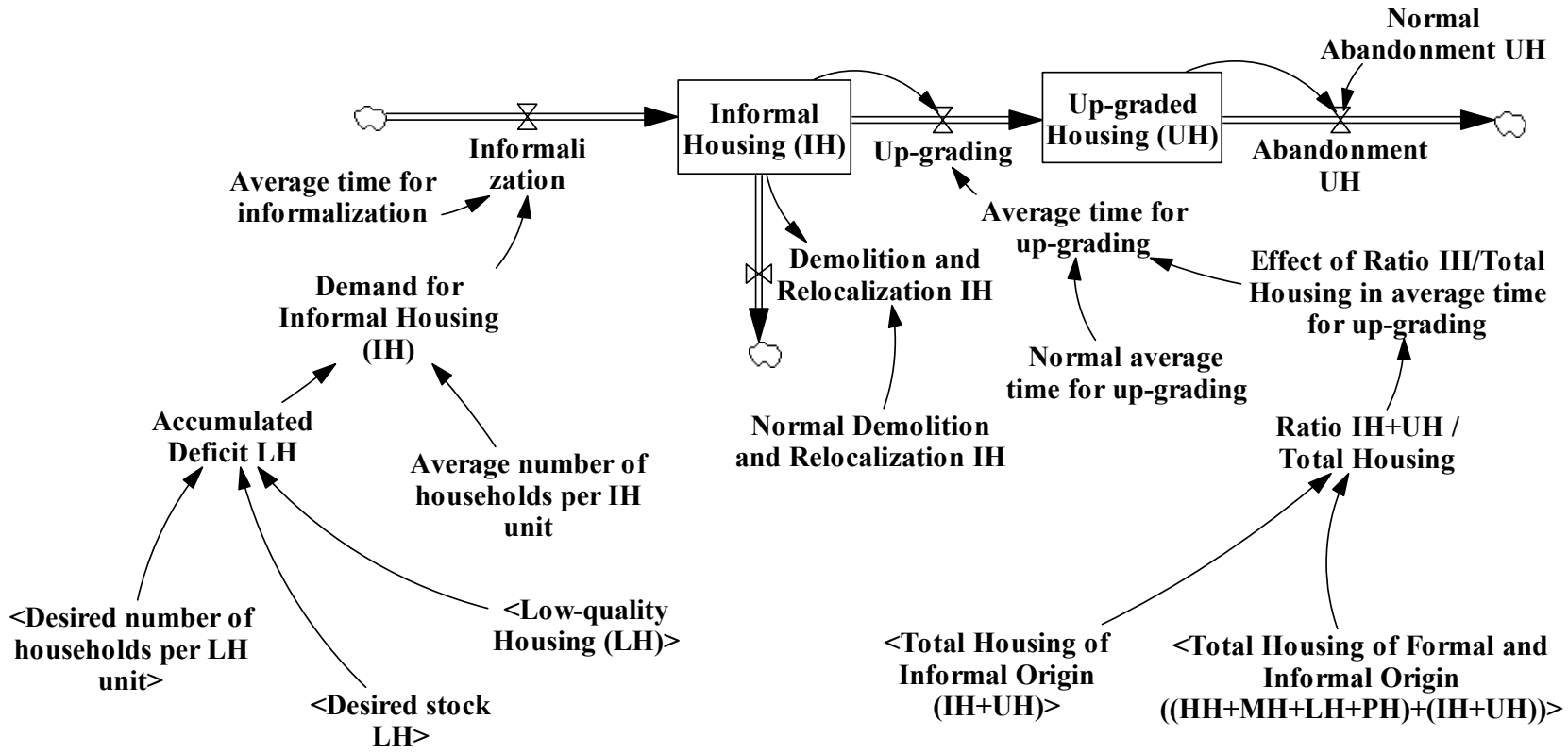
(93) Abandonment PH="Public Housing (PH)"/Normal Abandonment PH
Units: housing units/Year

(94) Normal Abandonment PH=120
Units: Year

Equations 89 to 94 represent the stock of public housing. Equation 90 states that the only inflow to this stock is the annual production (described in the last section). Equations 91 and 92 define the outflow of demolition which is assumed to be equal to the demolition of low-quality housing units (the normal demolition time is the same) since there are not reasons to think that these flows should behave differently. Equations 93 and 94 represent the outflow of abandonment which is assumed to be less likely than the abandonment of low-quality housing (the normal abandonment time is twice that of low-quality housing) this is because the relative scarcity of public housing units and the fact that their price and mortgages are subsidized.

A.4 INFORMAL HOUSING

This sector represents the process of informalization and the evolution of the stock of informal housing in the city. It includes the operationalization of two policies, up-grading and relocalization. Its structure is represented in Figure A.4 and its equations are operationalized as follows:



FigureA.4 Informal Housing

Informalization

(95) "Demand for Informal Housing (IH)"=Accumulated Deficit LH/Average number of households per IH unit
Units: housing units

(96) Accumulated Deficit LH=(Desired stock LH-"Low-quality Housing (LH)")*Desired number of households per LH unit
Units: household

(97) Average number of households per IH unit=1.5
Units: household/housing unit

(98) Informalization=MAX("Demand for Informal Housing (IH)"/Average time for informalization, 0)
Units: housing units/Year

(99) Average time for informalization=1
Units: Year

(100) "Informal Housing (IH)"= INTEG (Informalization-Demolition and Relocalization IH-"Up-grading",2670)
Units: housing units

(101) Demolition and Relocalization IH="Informal Housing (IH)"/Normal Demolition and Relocalization IH
Units: housing units/Year

(102) Normal Demolition and Relocalization IH=600
Units: Year

Equations 95 to 99 represent the process of informalization. Equation 95 defines the demand for informal housing as the ratio of the deficit for low-quality housing to the number of households per informal unit. In essence, this condition is stating that informality will depend on the failure of the production of formal housing to absorb the increases in demand (equation 96). Equation 97 defines the average number of households per IH unit as 1.5. This number is higher than in the case of formal low-quality housing, which was assumed as 1, because crowding will be a rational response to the conditions of housing deficit households.

This is also related to one of the most important characteristics of informal housing: the 'urbanistic freedom' associated with the non-compliance of planning requirements that allows the expansion of the accommodations to generate extra-income through rental and commercial activities (Abramo, 2007). According to Gilbert (1999) two thirds of informal settlers in Bogotá obtain supplementary income from their houses and according to Doebele (1977) one third of informal units have rooms that are rented to other households. Extrapolating this information, it can be calculated that the average number of households per unit in the informal market is between 1.33 and 1.67. For the simulation an average of 1.5 was selected taking into account these descriptions and the fact that the average number of households in strata 1 and 2 is 1.54 (SDP, 2005).

This demand for informal housing is transformed in an inflow of informalization by dividing it by the average time of informalization (equation 98). This equation includes a control to prevent the inflow from becoming negative under the extreme condition that there is surplus of housing in the lower category. Equation 99 defines the average time of informalization as one year because most accounts describe that informal settlers occupy the land immediately after its acquisition and start the process of self-construction very quickly: according to Doebele (1977), 94 percent of informal settlers begin construction within a year as a way to reassure occupation. Equation 100 represents the stock of informal housing as the accumulation of informalization. The initial value of 2,670 units is taken from the estimation of Jaramillo (1980) about the informal stock in 1938. Equations 101 and 102 operationalize one of the two outflows affecting the stock of informal housing: the demolition and relocalization of informal units. The normal rate of this outflow is defined as being equal to the demolition of formal low-quality and public housing (the average time in all these cases is 600).

This is because, relocalization and eviction of informal housing in Bogotá are uncommon in part because of the prevalence of the system of 'pirate subdivision' in which legal owners subdivide and sell peripheral land to informal settlers. In this system, as opposed to the pattern of 'invasion' of public or private land which is widely found in other Latin American cities, the transaction can be considered legitimate because it is consensual, although it cannot be considered completely legal since the subdivision and urbanization are not approved by the planning department. For these reasons, forced evictions, which are common in the cases of invasion, and squatting, are rare in the overall picture of informality in Bogotá since the number of housing units produced through these processes is less than 0.7 percent of the total stock (Gilbert, 1981). In general, relocalization only takes place when the informal units are located in zones of hazard risk (Roda, 2000).

Up-grading

(103) "Up-grading"="Informal Housing (IH)"/"Average time for up-grading"
Units: housing units/Year

(104) "Average time for up-grading"="Normal average time for up-grading"*"Effect of Ratio IH/Total Housing in average time for up-grading"
Units: Year

(105) "Normal average time for up-grading"=30
Units: Year

(106) "Ratio IH+UH / Total Housing"=
"Total Housing of Informal Origin (IH+UH)"/"Total Housing of Formal and Informal Origin ((HH+MH+LH+PH)+(IH+UH))"
Units: Dmnl

(107) "Effect of Ratio IH/Total Housing in average time for up-grading" = WITH LOOKUP("Ratio IH+UH / Total Housing",([(0,0)-(1,1)],(0,1),(0.25,0.75),(0.5,0.5),(0.75,0.25),(1,0.0001)))
Units: Dmnl

(108) "Up-graded Housing (UH)"= INTEG ("Up-grading"-Abandonment UH, 0)
Units: housing units

(109) Abandonment UH="Up-graded Housing (UH)"/Normal Abandonment UH
Units: housing units/Year

(110) Normal Abandonment UH=240
Units: Year

Equations 103 to 110 represent the process of up-grading. Since this process entails the provision of services to informal settlements a posteriori, it has been defined as an outflow from the stock of informal housing (equation 103) that creates a stock of up-graded housing (equation 108), which, although its informal origin, is qualitatively different from the informal stock. The rate of up-grading is defined by the average time for up-grading (equation 104). In the initial conditions of the model in 1938 this time is defined as 30 years (equation 105). This is because qualitative information suggests that in Bogotá before 1950 the average period between the origination of an informal settlement and its legalization, a process related to up-grading, was more than 24 years (*Secretaría del Habitat and Universidad Piloto de Colombia*, 2008).

This initial 'normal' time is assumed to be affected by the incidence of informality in the city: if a higher proportion of the built space is informal there will be more pressure to up-grade these units since the negative externalities produced by the lack of services will start to affect formal areas. Likewise, as the up-graded stock grows the situation for non-up-graded informal settlers will become less bearable and there will also be more pressure for up-grading. This process is captured in equations 106 and 107 that transform the proportion of housing of informal origin, the informal and up-graded stocks, to the total stock into an effect that decreases the average time for up-grading as the incidence of informality increases.

Equation 107 represents this effect through a 'table function' (a relation of independent and dependent variables) as a perfectly linear relation stating that when

the proportion of informal settlements to the total stock is zero the effect is null and that for each percentage point increase in the proportion, the normal initial time decreases in one percentage point. This linear relation was assumed since it was not possible to find information that suggested other type of relation. The table function excludes an effect equal to zero to prevent a mathematical error in the extreme condition that 100 percent of the stock is informal.

Equation 108 defines the stock of up-graded housing as the accumulation of up-grading. Equation 109 defines abandonment as an outflow from this stock. In equation 110 a lower rate of abandonment than in the formal stocks is assumed (the time for abandonment is four times that of low-quality housing and twice that of public housing) since up-graded units have the advantages of 'urbanistic freedom' that allow the expansion and adaptation of the space (Abramo, 2007).

A.5 TOTAL HOUSING OF FORMAL AND INFORMAL ORIGIN

This sector aggregates the information produced in the model into auxiliary variables that are comparable to the historical data of the housing stocks in Bogotá that serve as reference mode in this model. Its structure is represented in Figure A.5 and its equations are operationalized as follows:

(111) "Total Housing of Formal Origin (HH+MH+LH+PH)"="High-quality Housing (HH)"+"Middle-quality Housing (MH)"+"Low-quality Housing (LH)"+"Public Housing (PH)"
Units: housing units

(112) "Total Housing of Informal Origin (IH+UH)"="Informal Housing (IH)"+"Up-graded Housing (UH)"
Units: housing units

(113) "Total Housing of Formal and Informal Origin ((HH+MH+LH+PH)+(IH+UH))"="Total Housing of Formal Origin (HH+MH+LH+PH)"+"Total Housing of Informal Origin (IH+UH)"
Units: housing units

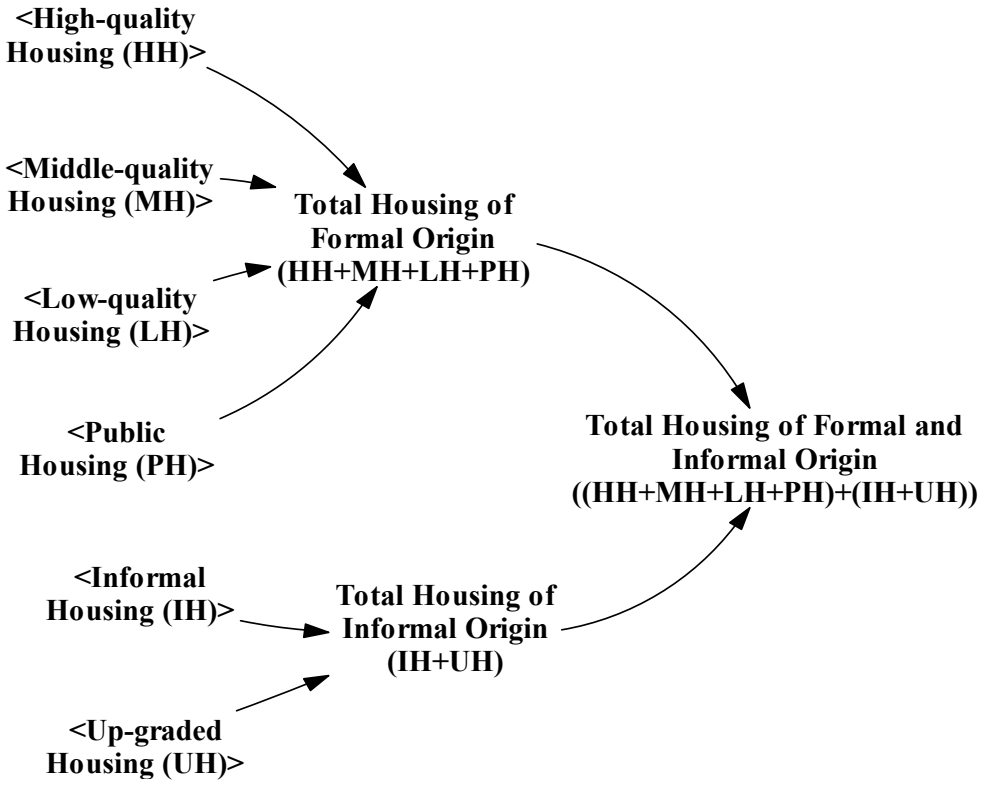


Figure A.5 Total Housing of Formal and Informal Origin

Equation 111 defines the stock of housing of formal origin as the sum of high-, medium-, and low-quality stocks plus the stock of public housing. Equation 112 states that the stock of total housing of informal origin is equal to the informal and up-graded stocks. Equation 113 aggregates all these stocks to calculate the total housing stock in the city.

A.6 TOTAL COSTS OF PROVISION OF LOW-INCOME HOUSING

This sector represents the total cost of provision of low-income housing calculating auxiliary variables that capture the cost of provision of services as well as the costs of interventions such as public housing and relocalization. To represent the redistributive dimension of the provision of low-income housing the costs are disaggregated in public costs paid through contributions or from the general budget and cost paid by the low-income households. The structure of this sector is represented in Figure A.6 and its equations are operationalized as follows:

Cost of service provision for low-quality housing

(114) Cost of Production LH=Normal Cost of Production LH*(1-"Minimum Requirements Policy 1973 - 1980"-"Minimum Requirements Policy 1991 - 1997")
Units: LTAC/housing units

(115) Normal Cost of Production LH=1
Units: LTAC/housing units

(116) Annual Public Cost of Production LH=Production LH*(Cost of Production LH-Tariff LH)
Units: LTAC/Year

(117) Accumulated Public Cost of Production LH= INTEG (Annual Public Cost of Production LH,0)
Units: LTAC

(118) "Annual Cost of Production LH for Low-income Households"=Production LH*Tariff LH
Units: LTAC/Year

(119) "Accumulated Cost of Production LH for Low-income Households"= INTEG ("Annual Cost of Production LH for Low-income Households",0)
Units: LTAC

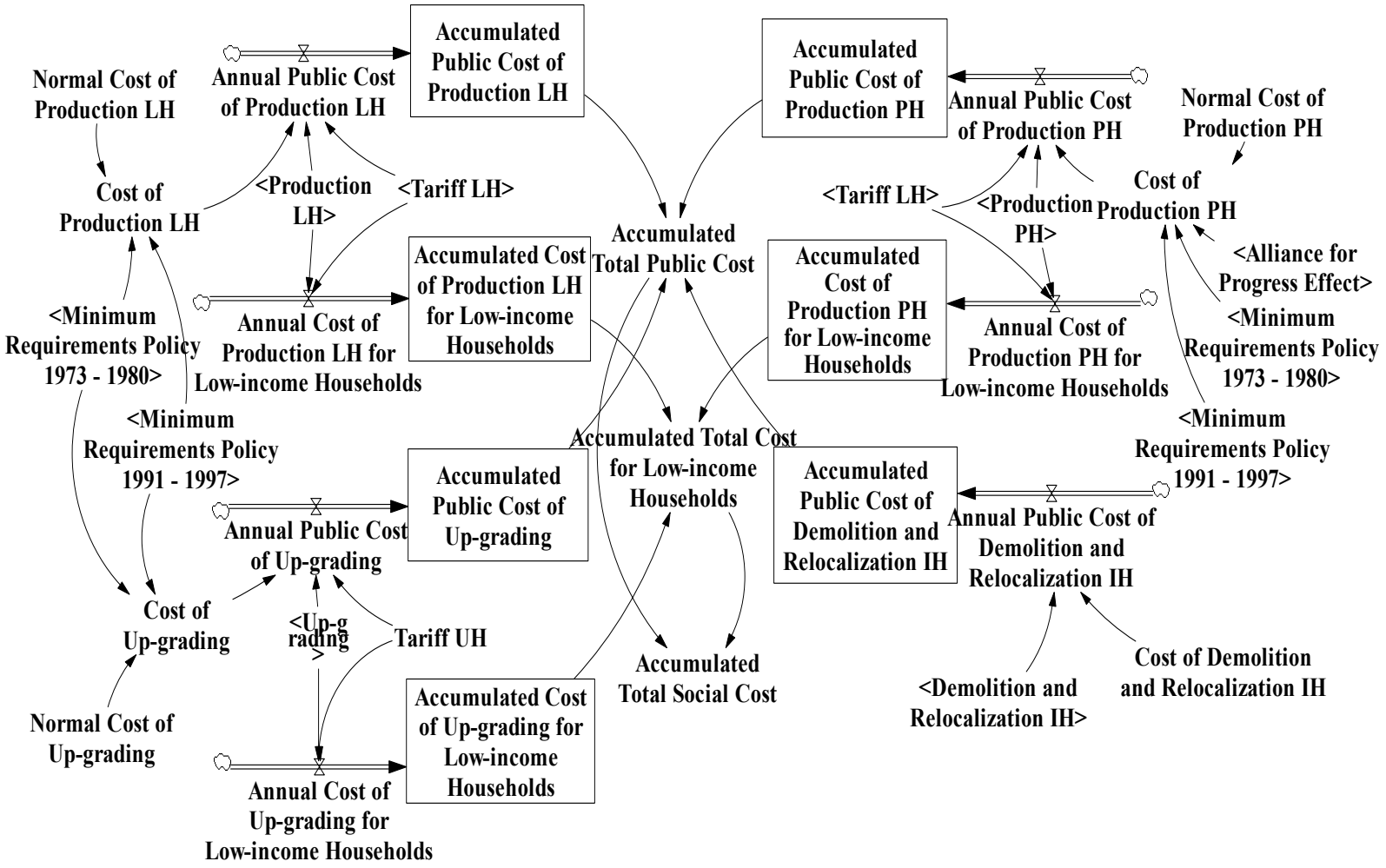


Figure A.6 Total Cost of Provision of Low-income Housing

Equations 114 and 115 represent the cost to provide services to low-quality housing. In normal conditions this cost per unit is equal to the average long term cost of service provision (equation 115) but it decreases with the policy of minimum requirements since this intervention lowers the average cost for this type of housing (equation 114). Part of this cost is paid by the same households occupying low-quality housing through the tariff, so the annual cost for low-income households in a given year is the tariff times the production (equation 118) and the accumulated cost is its integral (equation 119). The other part is paid through cross-subsidies from contributions and through transferences from the general budget. Equation 116 represents the annual public cost as the difference between the costs of provision and the tariff (i.e. the subsidy) times the production of low-quality housing. Equation 117 represents the accumulation of this public cost.

Cost of service provision for up-graded housing

(120) "Cost of Up-grading"="Normal Cost of Up-grading"*(1-"Minimum Requirements Policy 1973 - 1980"-"Minimum Requirements Policy 1991 - 1997")
Units: LTAC/housing units

(121) "Normal Cost of Up-grading"=3
Units: LTAC/housing units

(122) "Annual Public Cost of Up-grading"="Up-grading"*("Cost of Up-grading"-Tariff UH)
Units: LTAC/Year

(123) Tariff UH=1
Units: LTAC/housing units

(124) "Accumulated Public Cost of Up-grading"= INTEG ("Annual Public Cost of Up-grading",0)
Units: LTAC

(125) "Annual Cost of Up-grading for Low-income Households"="Up-grading"*Tariff UH
Units: LTAC/Year

(126) "Accumulated Cost of Up-grading for Low-income Households"= INTEG ("Annual Cost of Up-grading for Low-income Households",0)
Units: LTAC

As it was explained in the description of the second sector of the model, the cost of up-grading a unit was estimated at 3 times the cost of providing a formal unit, which is equivalent to 3 long term average costs (equation 121). This cost is affected by the policy of minimum requirements (equation 120). One third of it is paid by the households through tariffs and contributions in money and time (equation 123) and two thirds are paid by the public sector through cross-subsidies and transferences from the general budget (equation 122). The total annual costs for the public and the low-income households are obtained using these weights and the total production per year (equations 122 and 125) and the accumulated costs are the integral of the annual costs (equations 124 and 126).

Cost of service provision for public housing

(127) Cost of Production PH=Normal Cost of Production PH*(1-"Minimum Requirements Policy 1973 - 1980"-"Minimum Requirements Policy 1991 - 1997")*Alliance for Progress Effect
Units: LTAC/housing units

(128) Normal Cost of Production PH=6
Units: LTAC/housing units

(129) Annual Public Cost of Production PH=Production PH*(Cost of Production PH-Tariff LH)
Units: LTAC/Year

(130) Accumulated Public Cost of Production PH= INTEG (Annual Public Cost of Production PH,0)
Units: LTAC

(131) "Annual Cost of Production PH for Low-income Households"=Production PH*Tariff LH
Units: LTAC/Year

(132) "Accumulated Cost of Production PH for Low-income Households"= INTEG ("Annual Cost of Production PH for Low-income Households",0)
Units: LTAC

The total costs per public unit include not only the costs of trunk and secondary service provision paid by the utilities but also the costs of housing subsidies and written-off debts paid from the budget of the housing authorities. According to information from Roda (2000) this total cost per public unit was estimated at 6 times the cost of providing trunk services to a formal unit, which is equivalent to 6 long term average costs (equation 128). This cost is affected not only by the policy of minimum requirements but also by the pilot tests of this policy conducted in the projects funded by the Alliance for Progress (equation 129). Part of this cost is covered by the households through tariffs for public services, which in this case are equal to the tariff paid in low-quality housing. Therefore, the annual cost for low-income households is equal to the production times the tariff at any given year (equation 131) and the accumulated cost is equal to the integral of the annual production (equation 132). The rest is paid by the public sector through cross-subsidies and transferences (equations 129 and 130).

Cost of demolition and relocalization

(133) Cost of Demolition and Relocalization IH=5.5
Units: LTAC/housing units

(134) Annual Public Cost of Demolition and Relocalization IH=Demolition and Relocalization IH*Cost of Demolition and Relocalization IH
Units: LTAC/Year

(135) Accumulated Public Cost of Demolition and Relocalization IH= INTEG (Annual Public Cost of Demolition and Relocalization IH,0)
Units: LTAC

The costs for relocalization of informal housing involve a payment from the municipality recognizing the improvements achieved through the process of self-

construction. In addition, in more than 70 percent of the cases it involves technical assistance, a subsidy, and access to credit to facilitate the process of finding an alternative accommodation in the formal market. Using information from Roda (2000) and weighting these factors the average cost of relocalization was estimated at 5.5 the cost of providing trunk services to formal unit, or 5.5 long term average costs (equation 133). The annual cost of relocalization is the cost per unit times the number of relocalized units (equation 134) and the aggregate cost is integral of the annual cost (equation 135).

Total costs for public sector and low-income households

(136) "Accumulated Total Cost for Low-income Households"="Accumulated Cost of Production LH for Low-income Households"+"Accumulated Cost of Production PH for Low-income Households"+"Accumulated Cost of Up-grading for Low-income Households"
Units: LTAC

(137) Accumulated Total Public Cost=Accumulated Public Cost of Production LH+Accumulated Public Cost of Production PH+"Accumulated Public Cost of Up-grading"+Accumulated Public Cost of Demolition and Relocalization IH
Units: LTAC

(138) Accumulated Total Social Cost=Accumulated Total Public Cost+"Accumulated Total Cost for Low-income Households"
Units: LTAC

The accumulated total cost for low-income households is the sum of the accumulated costs for low-quality, up-graded, and public housing that are paid by the households (equation 136). The accumulated total cost for the public sector is the sum of the accumulated costs for low-quality, up-graded, and public housing plus the cost of demolition and relocalization, costs that are paid by the utilities with monies from contributions and by transferences from the general budget (equation 137). The total cost for society is the sum of the costs for the households and the public sector (equation 138).

Table A.2 summarizes the costs according to the type of intervention. This table presents a description of the intervention, the monetary cost per housing unit in Colombian Pesos (COP) of the year 2000, the cost in terms of long term average cost (LTAC), and the information source. It is important to note that the costs of maintaining the infrastructure are assumed to be proportional to the cost of the investment. Therefore, the number of LTAC per intervention is calculated by dividing its cost by the cost of providing trunk services for a formal low-quality unit.

Table A.2 Costs of Different Public Interventions in Bogotá

Intervention	Description	Cost in COP	Cost in LTAC	Source
Service Provision	Includes trunk infrastructure	$1,350,000	1	Roda (2000)
Public Housing	Includes trunk and secondary infrastructure, and housing subsidy	$7,879,200	6	Roda (2000)
Service Provision for Public Housing	Includes trunk and secondary infrastructure	$3,150,000	2.33	Roda (2000)
Demolition and Relocalization (simple: 29 percent of cases)	Includes payment recognizing the improvements of self-construction	$3,000,000		Roda (2000)
Demolition and Relocalization (complete: 71 percent of cases)	Includes payment recognizing the improvements plus technical assistance, and housing and credit subsidy	$9,090,000		Roda (2000)
Demolition and Relocalization (aggregated)	Weighted average of the costs of relocalization according to the incidence per type (simple and complete)	$7,323,000	5.5	Roda (2000)
Up-grading	Includes trunk infrastructure (and in some cases secondary infrastructure) a posteriori		(2,5 to 3,78)	Roda (2000), Aristizabal and Gomez (2002), Cities Alliance (2006)

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