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The Housing Transition in Mexico:
Local Impacts of National Policy

by

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B.A. (University of California, Berkeley) 2000
M.P.P. (University of California, Los Angeles) 2005

A dissertation submitted in partial satisfaction of the

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Doctor of Philosophy

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of the

University of California, Berkeley

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Professor John M. Quigley
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The Housing Transition in Mexico:
Local Impacts of National Policy

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by

Paavo Herbert Monkkonen

Abstract

The Housing Transition in Mexico: Local Impacts of National Policy

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Doctor of Philosophy in City and Regional Planning

University of California, Berkeley

Professor David E. Dowall, Chair

The dramatic reform and expansion of Mexico's housing finance system since the early 1990s has transformed production and acquisition of housing in Mexico. More housing is now built by formal private sector construction companies and purchased with mortgages than through the informal, incremental process that traditionally housed the majority of the population. Most housing finance is provided by government lenders, with tight restrictions on eligibility for loans and on the houses they can be used to purchase. These restrictions have consequential secondary effects on urban development in the country; leading to neighborhoods that have a more homogenous housing stock and are more segregated. Understanding the impact of housing finance on the homebuilding industry, access to housing, regional development, and residential segregation is critical to understanding the rapid transformation of national life and culture as Mexico moves into the twenty-first century.

The dissertation opens with a history of housing finance in Mexico, documents the housing transition quantitatively, and explores the implications of restricting housing finance to formal, salaried employees, which make up roughly half the workforce in

Mexico. It is shown that otherwise identical households with a salaried household head are between 10 and 20 percent more likely to live in a consolidated house than are those with a part-time or informally employed head. Furthermore, by directing housing investment to cities with more salaried workers, the finance system functions as a regional development policy, favoring manufacturing centers in the north.

The third chapter focuses on the reorganization of the residential construction industry, documenting the rise of large, national homebuilding firms. The impact of mortgage lending from government agencies is shown to be a significant determinant of variation in the size of construction firms and levels of market concentration at the metropolitan level. Cities with larger shares of lending have larger firms, but lower levels of market concentration and lower prices.

The remainder of the dissertation focuses on the impact of Mexico's new urban growth patterns on residential segregation. Chapter four adapts commonly used measures of segregation in the United States to the 128 metropolitan statistical areas in Mexico to describe patterns of residential segregation by ethnicity and socioeconomic status. It is the first systematic quantitative analysis of segregation patterns in a Latin American country. The fifth chapter analyzes changes in levels of socioeconomic segregation, testing a number of hypotheses about the drivers of segregation. Findings show that characteristics of land and housing markets, including the share of housing that is acquired under the new housing finance system, are significant and important determinants of levels of segregation, growth of segregation during the 1990s, and the share of socioeconomic segregation that is conditional on the distribution of the housing stock.

The results of the dissertation have important implications for Mexico and for all countries seeking to emulate the success of the expanded housing finance system there. In Mexico, the demographic structure of the population means that cities will continue to grow rapidly for at least the next 20 years. Because the housing finance system is run primarily by government agencies, an understanding of the secondary impacts of the system can be used to modify further reform; expanding access to the system and build cities that are more efficiently organized and less segregated. This experience will also be useful for other countries, which can incorporate considerations about the urban form of the neighborhoods that will be built under a government housing finance system before it is created.

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Professor David Dowall

Dissertation Committee Chair

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In memory of Eric Monkkonen,
1942 - 2005

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Chapter 1
Introduction

1.1 Introduction

This dissertation analyzes a fundamental change in the way housing is produced and acquired in Mexico, a change with origins in the reform and expansion of the government housing finance system that began in the early 1990s. Defined in the second chapter, the housing transition refers to the fact that at some point between 2000 and 2005, the majority of households in Mexico purchased a house built on speculation by a private sector construction company with a mortgage. Previously, the majority of households had acquired housing through an incremental, often informal, process of self-help, in which they would purchase land and oversee the construction of a house themselves. Not only does the transformation in the housing system in Mexico impact participating households directly, it also has consequential secondary impacts on urban and regional development in Mexico, and Mexican society.

The goal of this dissertation is to frame and test several hypotheses about the way in which changes in the structure of the housing finance system have altered the nature of housing production and acquisition, and how these changes have impacted urban and regional development in Mexico. The dissertation was written as a set of four independent articles, rather than one continuous manuscript, although there is a continuity and logical order to the chapters. Nevertheless, because each chapter is

intended to stand alone, they each contain a literature review, and some background on the housing finance reform and research strategy is repeated.

The chapter following this introduction presents background on the housing finance system and reforms it underwent during the 1990s. In addition, it defines the housing transition and documents it quantitatively, using data on housing loans and housing quality at the city level. Finally, the chapter tests the impacts of the restrictions on access to housing finance at the household and regional level. The primary restriction on lending for housing is that the majority of mortgages are only available to formal, salaried employees, which make up roughly half the workforce in Mexico. Thus, it is not surprising that otherwise equal households are significantly more likely to live in housing of high quality if the household head has salaried employment. Furthermore, since housing investment is allocated based on the number of salaried workers in a state, it functions as a regional development policy as well, favoring manufacturing centers in the north over southern regions that depend more heavily on tourism or agriculture, industries with lower shares of salaried employees.

The third chapter focuses on the reorganization of the residential construction industry. It documents the way in which the reform of the housing finance system, which is dominated by government lenders, was instrumental in fomenting the rise of large, national homebuilding firms. Also, the hypothesis that the size of construction firms and levels of market concentration are determined in part by the share of construction that depends on lending from government agencies is tested. Controlling for other factors

found in the literature to be significant determinants of the structure of the homebuilding industry, the share of housing built under the new finance system in a given city is found to be significantly and importantly associated with larger firms. However, at the same time, more lending is associated with less market concentration and based on limited evidence, lower prices for new housing, suggesting that the new system promotes competition, or at least economies of scale.

The second half of the dissertation analyzes patterns of residential segregation in Mexico and the impact of recent changes in urban development on segregation. A dearth of quantitative analysis of segregation patterns in Mexico and Latin America led to an entire chapter dedicated to a baseline analysis of residential segregation using measures common in the United States. In this chapter, commonly held ideas about patterns of residential segregation by ethnicity and socioeconomic status in Latin American cities are evaluated and contrasted with the spatial distribution of socioeconomic and ethnic groups in other countries.

The fifth and final chapter analyzes changes in levels of socioeconomic segregation, testing a number of hypotheses about the drivers of segregation. The central hypothesis is that residential segregation has been significantly influenced by Mexico's new urban growth patterns, which in turn stems from housing finance reform. Findings show that characteristics of land and housing markets, including the share of housing that is acquired under the new housing finance system, are significant and important

determinants of levels of segregation, growth of segregation during the 1990s, and the share of socioeconomic segregation that is conditional on housing quality.

1.2 Data and Research Strategy

The research reported on in this dissertation is based on a national set of data on housing finance and urban development in Mexico, the first of its kind. A variety of sources were combined, principally census and geographic data from Mexico's National Institute of Statistics, Geography and Information Technology (INEGI), which was accessed directly from the agency, as well as through the Integrated Public Use Microdata Series (IPUMS). Data on housing finance is from the National Housing Commission (CONAVI) and some data on land use were obtained from the Secretariat of Social Development (SEDESOL). The reliability, quality, and scope of census and other data in Mexico has grown significantly in recent years, and is now much more useful for urban analysis than data from other countries in Latin America, or most countries at a similar level of economic development.

Nevertheless, a variety of data limitations meant that several important research questions associated with the housing transition could not be addressed. The most important limitation is the inability to link data on housing finance directly to household data from the census. Thus, although it is possible to examine the housing quality impact of salaried employment, as in chapter two, it is not possible to study the characteristics of households that have used a loan to purchase their house. Additionally, data on housing

finance is only referenced geographically to a municipality, thus it is not possible to document the concentration of lending in suburban areas, for example, or the concentration of lending in large housing developments.

The second largest limitation in the data on housing and urban development in Mexico is an almost complete lack of price data for housing or land. The census does not ask respondents to estimate the value of their house, housing sales prices are not recorded, and municipal private property registries are not reliable in the least. Thus, although some models of house prices are tested in chapter three using data from the website of a large residential construction company, several research questions related to the impact of lending on housing prices are not answerable.

The research approach in all sections of the dissertation was based on analysis and development of indicators at the city level. Thus, the first step in the project was to define the cities that would be included in the analysis. These cities were defined according to the definition from the United States census bureau (municipalities[1] with an urban core of more than 50,000 people). The definition of the United States census bureau is used because that of the Mexican government considers only those urban areas that encompass more than one municipality to be metropolitan, thus excluding many large cities (Secretaría de Desarrollo Social, Consejo Nacional de Población, and Instituto Nacional de Estadísticas, Geografía e Informática 2004). Figure 1 maps the 128 metropolitan statistical areas (MSAs) identified for the dissertation in the year 2000, with circles

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[1] Municipalities in Mexico are equivalent to counties in the United States. Mexico has no equivalent to incorporated cities.

proportional to their population in the year 2005. These 128 MSAs were home to 70 of the 106 million people in Mexico in 2005.
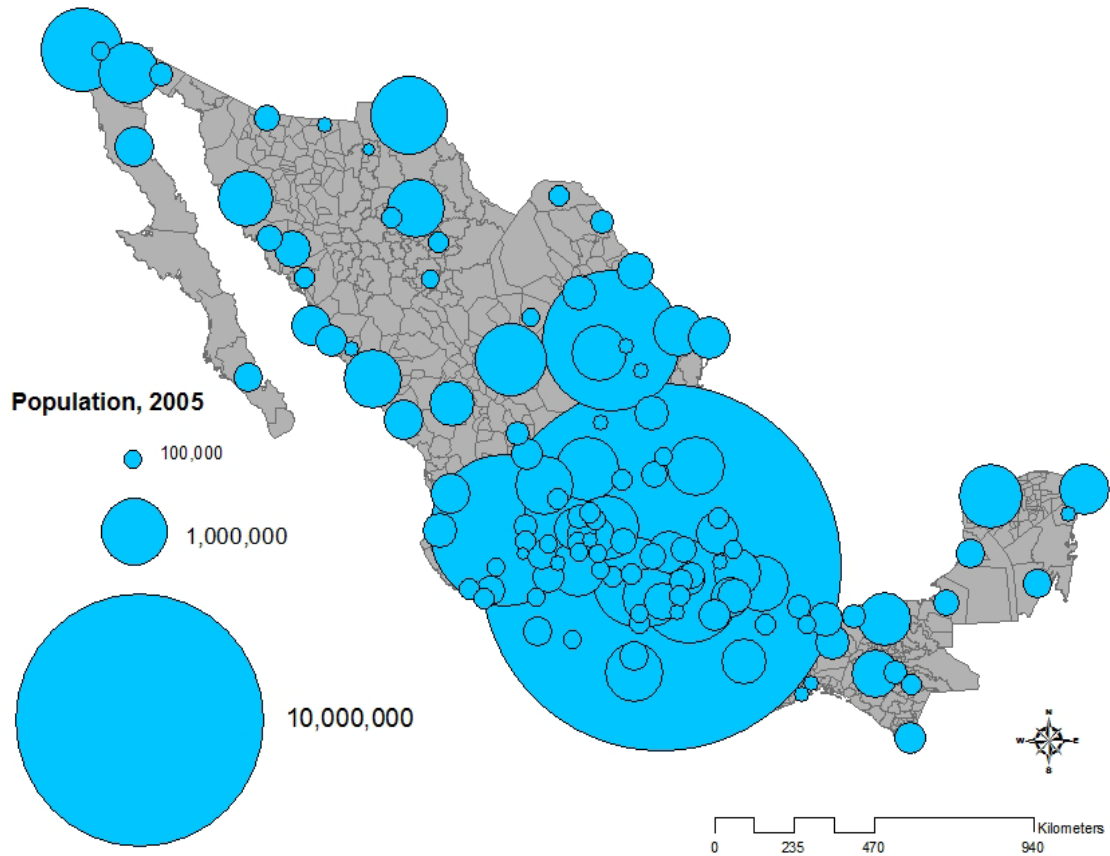
Figure 1.1 Distribution of metropolitan areas in Mexico, sized by municipal population, 2005

The most salient feature of the map in figure 1.1 is the size of Mexico City (the largest circle) relative to other cities in the country. With a population of almost 20 million, it is roughly 4 times the size of the next largest city making it a classic example of a primate city. However, current urban growth trends show a decentralization of population growth

to medium-sized and large cities. A discussion of the role of the housing finance reform and housing transition in decentralization trends can be found at the end of chapter two.

1.3 Contributions of the Dissertation

This dissertation contributes to several academic fields – housing studies, city and regional planning, sociology, and real estate and urban economics – and will hopefully provide useful information about the secondary effects of housing finance reform to policy makers in Mexico and other countries seeking to emulate the success of the expanded housing finance system there. Although Mexico is already a highly urbanized country, the demographic structure of the Mexican population means that cities will continue to grow rapidly for at least the next 20 years. The current patterns of urban development in the growing cities are very important as they will be composed mainly of neighborhoods built under the new system.

Policymakers should pay special attention to the housing condition and regional development impacts of the restricted access to housing finance, which are explored in detail in chapter two. The current lending system is only available to salaried employees, putting those without access at a serious disadvantage. Efforts to expand the benefits of access to housing finance to those with part-time or informal work should be a high priority for government lenders.

The analysis of the relationship between lending and the residential construction industry in chapter two contributes both to an understanding of the emerging private sector construction industry in a developing country, as well as to comparative literature on the industrial organization of housing supply. The fact that in spite of its association with large construction firms, government lending seems also to lead to more competition and lower prices was unexpected, and important.

The analysis of determinants of segregation and changes in segregation in Mexican cities makes an important contribution to literature in planning, urban economics, and sociology as it frames and tests four groups of determinants of segregation; economic, urban growth, land-use, and housing market factors. No study has previously compared the impacts of such a variety of determinants of segregation, let alone in a developing country. Thus, the finding that land-use and housing market characteristics of cities are more important than economic factors in their impact on segregation is significant.

Yet ironically, it is possible that the largest contribution of the dissertation will be found in chapter four, the only chapter that does not test a hypothesis regarding the impact of housing finance on urban development. This chapter provides the first systematic quantitative analysis of segregation patterns in a Latin American country, and thus is able to test many commonly held ideas about the spatial distribution of different populations in the region. Given the current interest in spatial patterns of segregation in Latin America, this analysis provides an important comparison for segregation patterns in other countries.

Chapter 2
The Housing Transition

2.1 Introduction

The cities of Mexico are in the midst of dramatic change. Reform and expansion of the national housing finance system that began in the early 1990s has transformed the housing production system from one dominated by the informal sector, in which households build their own houses incrementally and outside of formal regulation, to one in which most housing is built by the private sector and purchased with mortgages. The majority of housing finance comes from government agencies, with tight restrictions on access to loans and the housing that can be purchased with them.

Two structural aspects of the finance system have consequential secondary effects. The first is the restricted access to finance and is the focus of this paper. Government loans for housing are available only to people with salaried employment, roughly 60 percent of the working population in Mexico. Salaried employees do not only have access to government run housing finance agencies, they are induced to use this system. All salaried employees pay a mandatory 5 percent payroll tax to the National Workers' Housing Fund (INFONAVIT), which supplies the majority of mortgage finance in the country. This connection between salaried employment and housing finance has important ramifications for housing conditions–otherwise equal households with a household head that has a salaried job are between 10 and 19 percent more likely to live in a house that is built of permanent materials and has access to infrastructure.

Additionally, it functions as an implicit regional development policy, channeling investment in housing to northern manufacturing centers as these places have larger shares of salaried employees.

The complex restrictions on the type of housing eligible for government financing is the second structural feature of the new system that has significant secondary impacts. Although housing requirements have become more flexible recently, they continue to direct would-be homebuyers to new housing and to large developments–with obvious impacts on urban development in Mexico. The most direct outcome of housing finance reform is the rise of large homebuilding firms that have a close relationship with government lenders. Secondly, the high-density and peripheral locations of many new housing developments in Mexico are departures from traditional urban growth patterns and have potentially negative impacts, especially regarding transportation and congestion. Finally, restricted access to the housing finance system is likely to produce new neighborhoods that are more segregated by income than those built incrementally over time.

The products of the new housing system have come under attack from Mexican architects and *urbanists*. Large developments of identical, frequently small, tract houses have elicited a reaction similar to that heard in the United States after the explosion of suburban growth in the 1950s, when critics argued that huge developments of standardized housing create soulless and unlivable places (Whyte 1956; Mumford 1961). As the relative merits of suburban living versus urban neighborhoods remains unresolved

after several decades of attention in the United States, this seems the least fruitful subject for research or policy attention in Mexico. The comparison to the debate over suburbanization in the United States is also complicated by the fact that many of the new housing developments in Mexico are high-density, in contrast to the low-density suburbs of the United States.

More relevant criticism of Mexico's new housing developments points to deficiencies in industries and sectors supportive to housing, in which problems have emerged as the formal housing construction industry has grown. For example, the combination of an underdeveloped savings system, low property taxes, and laws favoring renters rights means that new houses are often purchased but left vacant as a savings mechanism (Joint Center for Housing Studies 2004). A combination of un-standardized property appraisal systems and minimal credit bureau data means that securitization difficult due to uncertainty in the value of the underlying assets (Zanforlin and Espinosa 2008). Finally, on account of the pace of development and lack of planning capability in municipal governments, many newly developed areas are peripheral to urban centers and lack access to urban amenities such as supermarkets for several years after they are built (Maya and Cervantes 1999).

Yet in spite of the drawbacks of the new home-building system, the creation of a functioning mortgage system must be acknowledged as an achievement. Under the new system, large numbers of people now live in consolidated housing – that is, housing built of permanent materials and with access to basic services. Getting a mortgage to buy a

house built by a developer is far more efficient, both individually and systemically, than the incremental development process that has been the tradition in Mexico. For individuals, long-term financing for the purchase of a house allows for consumption smoothing, the balancing of spending and saving over a person's life that can maximize their standard of living. The new system frees homeowners from the obligation to act as contractors in the construction of their houses, allowing them to dedicate this time to their own profession. The new housing production system also supports a growing financial industry in Mexico and increases people's familiarity with banks. Finally, the efficiency of housing markets will improve as regulations that govern buying, selling, and renting of housing in Mexico are reformed.

This paper is divided in three sections. The first provides a brief history of the housing finance system in Mexico and the reforms it has undergone in recent years. The second section explores the transition in housing production quantitatively, using data on lending from the National Commission on Housing (CONAVI) and data on housing quality from the general census of population and housing to demonstrate how expanded lending has led to the transformation in the housing production system. The final section explores the implications of restricted access to mortgage lending, showing the difference between housing conditions of households with salaried versus non-salaried employment as well as regional investment trends.

2.2 Housing Finance in Mexico

The housing transition in Mexico was made possible by changes during the 1990s, including the surge of *maquiladora* employment and growth of northern cities after the signing of the North American Free Trade Agreement (NAFTA) and the manifestation of global policy trends in the reform of the housing finance system. The transition began at the end of 1994 after a questionable presidential election, several political assassinations, an armed rebellion in Chiapas, and the continual drawdown of dollar reserves led to a dramatic devaluation of the Mexican peso and economic crisis in the country (DeLong et al 1996; Edwards 1998). The impact of the crisis on the housing sector was dramatic; banks, which until 1994 played a large role in the mortgage market, ceased lending for housing completely.

Although private banks withdrew from the housing finance market, government agencies that had already been an important source of mortgages continued to provide them. The most important organization in the Mexican housing finance system was and continues to be the Institute of the National Workers Housing Fund, INFONAVIT, a tripartite organization governed by workers' representatives, business, and government that was established to provide housing for workers. Other large government lenders include the Housing Fund of Institute of Social Security of State Workers (FOVISSTE), which provides loans to government employees; a trust fund of the central bank of Mexico (FOVI), which was created to provide loans for social interest housing; the Federal Electricity Commission (CFE) and Mexican Petrol (PEMEX), the two largest state-

controlled companies both of which offer housing finance for employees; and a National Fund for Popular Housing (FONHAPO), which provides subsidized loans for low-income people.

Government lending programs have all undergone reforms since their creation in the 1960s and 1970s, but it was not until the 1990s that they took the forms they have today. Though the largest changes have occurred in INFONAVIT, all lenders have vastly expanded operations through changes in three areas. First, lenders stopped building housing directly and focused exclusively on housing finance. Second, they set the goal of making finance available to all eligible parties and to this end began allocating loans through formulae rather than the lottery systems used in earlier periods. Third, government lenders become more efficient in several areas, rationalizing or eliminating implicit subsidies and subcontracting collections to ensure payment of loans that previously had been allowed to become delinquent. In the pages that follow, a brief history of the reform of INFONAVIT, FOVI and FOVISSTE documents these changes in more detail.

From its creation in 1972 until a series of reforms beginning in the early 1990s, INFONAVIT operated as a contractor as well as a mortgage lender, building housing directly and loaning funds generated from a tax on the wages of all formally employed workers. Housing units were allocated through an opaque system of lotteries, divided first among the different unions with positions on the fund's governing board and then among their members. By the late 1980s, however, INFONAVIT was almost bankrupt. A

recession reduced revenues and raised construction costs, while an absurd lending policy–with interest rates far below market and almost no recourse on collections leading to extremely high default rates–meant that the institution had to reduce both construction and lending significantly (Pardo and Sanchez 2006).

Thus, in 1992, INFONAVIT's lending policies were overhauled. It stopped building housing directly, shifting instead to a bank-like system with an emphasis on transparency and fairness in allocation of loans and a move to slightly larger loans with higher interest rates indexed to inflation and stricter loan recovery policies (Puebla 2002). It was during this reform that the agency faced a conflict of interest in its dual role of housing fund and pension. As a provider of worker housing it had tended to forgive delayed payments and not resort to repossession to keep people in their homes, yet this meant it was a completely ineffective savings fund for the very same workers. In 1992, the institution assumed the goal of lending as much as possible and earning a return on the investment, so that all subscribers might benefit from the system (Pardo and Sanchez 2006).

Lending policies were further modified to make loans more flexible in 1997. Until that point, subscribers could not save more than the required tax in or remove savings from their INFONAVIT accounts, houses purchased with INFONAVIT loans could not be sold to non-INFONAVIT subscribers, buyers could not purchase used houses, and funds in the INFONAVIT account could not be combined with loans from other financial organizations. Removing these restrictions served to boost INFONAVIT lending, and by 1998 it was issuing more than 100,000 loans per year, up from 70,000 in the late 1980s.

Reform of its financial management continued, including efforts to better calculate borrowers' ability to pay and stricter control of overdue loans.

The reforms of the late 1990s also included an initiative to foster expansion of the private construction industry in Mexico, which had suffered when banks ceased lending after 1994 and had never built enough housing at prices low enough to be accessible to most INFONAVIT subscribers. With the support of then-president Ernesto Zedillo, INFONAVIT convened a series of meetings with home-building companies in order to convince them that building houses linked to INFONAVIT loans could be profitable. The Institute facilitated access to loans for housing built by participating developers, offered builders construction loans with the house's mortgage, and assisted builders with the state and local permitting process as well as land acquisition. The so-called Commitment to Housing initiative proved successful, although the preferential treatment some builders received has been criticized (Pardo and Sanchez 2006). By 2004, the nine homebuilders that received preferential treatment had expanded operations to the whole country and were estimated to control 25 percent of the housing construction market (Centro de Investigación y Documentación de la Casa (CIDOC) and Sociedad Hipotecaria Federal (SHF) 2006).

Reform of INFONAVIT continued under the administration of Vicente Fox (2000 – 2006), and during that period the institute increased lending volume enormously, going from roughly 230,000 loans in 2001 to more than 420,000 in 2006 (Comisión Nacional de la Vivienda). Management of INFONAVIT passed to a group of professionals from

the financial sector in 2001, and they embarked on a modernization program to strengthen the Institute's financial position and increase lending to the rate set by the administration. Among the most important operational changes made during this period were the further division of labor of institute operations, with the subcontracting of many duties, new tax collection systems to ensure employees were paying their required contributions, and an overhaul of the loan allocation system. Until 2003, the INFONAVIT loan application process remained complicated. It required attending an infrequently held meeting at which loan eligibility was determined based on salary and length of employment, a process that was still seen as opaque and subject to corruption (Pardo and Sanchez 2006). Subscribers were also informed of housing for sale through INFONAVIT itself, which kept records of all housing approved for purchase. Allowing subscribers with sufficient funds in their accounts to obtain loans for houses they found on their own and to combine INFONAVIT funds with loans from other financial institutions made the huge increase in lending possible; it was also a large step in making INFONAVIT a more transparent and equitable organization.

FOVISSTE, the housing finance organization for government employees, operates in a manner similar to INFONAVIT, using funds from a 5 percent payroll tax to provide mortgage loans. FOVISSTE also underwent a series of reforms during the 1990s in order to focus exclusively on housing finance, increase the availability of loans for members, and allow co-financing opportunities with other sources. Despite attempts to base loan allocation on a formula accounting for job tenure, income, and age, FOVISSTE continues

to allocate loans by a lottery among members and to restrict housing eligible for purchase with FOVISSTE loans (Coulomb and Schteingart 2006).

The second largest source of government housing finance in Mexico is the Housing Fund (FOVI), which was created in 1963 as a trust fund in the central bank. It has several goals: providing funds for building social interest housing, issuing loans for new and used housing as well as housing improvement, and providing partial guarantees on loans issued by other financial agencies. FOVI funds were lent through banks until 1989; after that time they were allocated through a system of auctions to housing developers who then used them to finance the sale of houses in new projects (Coulomb and Schteingart 2006). Eligibility for loans was based on income and interest rates were subsidized until 1995. In 2001, FOVI was taken over by a newly created agency, the Federal Mortgage Society (SHF). Although the SHF manages the housing fund of the central bank, it was created with the primary goal of developing a secondary mortgage market by extending the guarantee program and standardizing initiation and administration of mortgages across agencies that originate loans (Babatz 2004).

In 2009, SHF will pass responsibility for managing FOVI monies to another recently created institution, a group of non-depository lenders known as Limited Financial Societies, or SOFOLES. The SOFOLES were created as part of NAFTA with funds from the Central Bank of Mexico, the World Bank, and the United States, with the goal of enabling US nonbank financial institutions and Canadian investment societies to participate in the Mexican mortgage market (Pickering 2000). The SOFOLES currently

originate loans with monies from SHF, but have increasingly obtained funds through mortgage-backed securities traded on the Mexican stock exchange, although the share of funds obtained through securitization remains small.

In addition to the reform of lending agencies, a series of other reforms in the housing sector were pursued during the 1990s. These reforms included collaborative efforts by federal agencies (such as the Secretary of Social Development), state governments, and organizations of notaries to reduce the regulatory burden on housing construction (Herbert and Pickering 1997); standardized lending criteria and appraisal practices across government lenders (Zanforlin and Espinosa 2008); the introduction of private mortgage insurance (CIDOC and SHF 2006); reform of bankruptcy law and the legal framework for credit bureaus (Skelton 2006); the updating and modernization of private property registries, from which cadastral values are calculated (Perló Cohen 2000); and an amendment to the Mexican Constitution that legalized the privatization of land governed by the communal, *ejido,* tenure system created during the Mexican revolution (Jones and Ward 1998).

Reforms in the housing sector were consistent with changes in Mexico's economic development strategy and the role of the state. The shift to a reduced role for the state began with the De la Madrid administration (1982–1988) after the crisis of 1982, which led the country from a strategy of import substitution to one of export-led industrialization, and continued with the Salinas administration (1988–1994), which privatized the majority of the country's nationally held concerns and negotiated the terms

of NAFTA. Thus, the reform of INFONAVIT and Mexican housing policy overall should be considered as part of efforts to reform the entire Mexican government according to ideas of the small state, decentralization, and the New Public Management (Puebla 2002).

Yet the most significant expansion in lending for housing did not occur until the victory of the opposition party, the Party of National Action (PAN), in the 2000 presidential election. Vicente Fox, president of Mexico from 2000 to 2006, made providing 750,000 housing loans per year one of the central platforms of his campaign (Comisión Nacional de la Vivienda 2005). The Fox administration also pursued several new housing initiatives in addition to expanding lending: creation of the SHF and the National Commission of the Promotion of Housing (CONAFOVI), agreements between federal and state government agencies involved in housing, efforts to simplify and streamline regulation of housing construction and to modernize cadastres and public registries of property, and providing public information about the availability of and eligibility for housing finance.

Finally, it bears noting that the World Bank played an important role in the reform of Mexico's housing finance system. Mexico has a deep relationship with the World Bank dating back to 1949 and is one of the largest recipients of World Bank lending (Zanetta 2004). Loans for urban development and housing programs have been an important part of the relationship since the 1970s. After the Mexican financial crisis of 1982, when World Bank lending operations in Mexico moved toward support for structural adjustment rather than project financing, the bank became involved with reform and

expansion of two government lenders, the FONHAPO and FOVI. Programmatic loans and technical assistance to federal housing finance agencies continue to this day (World Bank 2004; World Bank 2005). Thus, Mexico is used as an example of housing sector reform according to the enabling framework developed by the World Bank. The framework is based on five elements: clear and well-defined property rights, housing finance for all income levels, transparent and rationalized demand-side subsidies, supply of needed residential infrastructure, and appropriate and minimal regulation of building codes and land use (World Bank 1993; Zearley 1993).

2.3 The Housing Transition

This section describes the housing transition using data on lending and housing quality. Until recently in Mexico, most housing had been typically produced incrementally by individuals, without permits. As in most developing countries, families often occupy a piece of land first, erecting a makeshift structure, and slowly make the structure more permanent and add infrastructure over time as they are able to save enough money. Recently, however, Mexico has shifted to a system in which a majority of houses are built by private companies, in conformance with formal regulations and in consolidated form, with access to infrastructure.[2] Unfortunately, data on lending and on housing quality cannot be matched exactly – neither census data nor property records indicate whether a house was purchased with a mortgage. A rough match, however, is possible

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[2] Consolidated houses are those built with permanent materials, defined as walls of brick, block, stone, cement, metal, or asbestos sheet; floors of cement or tile; and a roof of masonry, concrete, tile, metal or asbestos. Access to infrastructure is defined as electricity, a sewage system or septic tank, and a water supply piped exclusively to the household.

because mortgages cannot be used to purchase houses that do not meet basic standards of materials and infrastructure, information that is available in census data. Thus, a general description of the evolution in the quality of housing stock in Mexico is provided first through data on urban housing from 1970 to 2000. Then, city-level associations between housing stock and lending are used to corroborate the connection. The data presented show that housing construction in Mexico experienced a transition shortly after the turn of the 21st century.

2.3.1 Data on Housing Loans

The National Housing Commission (CONAVI), previously known as the National Commission for the Promotion of Housing (CONAFOVI), was created in 2001 to serve as a coordinating agency between the different actors in the housing sector in Mexico. Its goal is to promote housing according to the guidelines set out by the federal government in the various development plans, most recently *The National Housing Program 2007– 2012: Toward Sustainable Residential Development* (Comisión Nacional de la Vivienda 2007). Among its other functions, CONAVI maintains several databases. The most complete one documents mortgage lending by volume and value at the municipal level, according to lending agency and purpose.
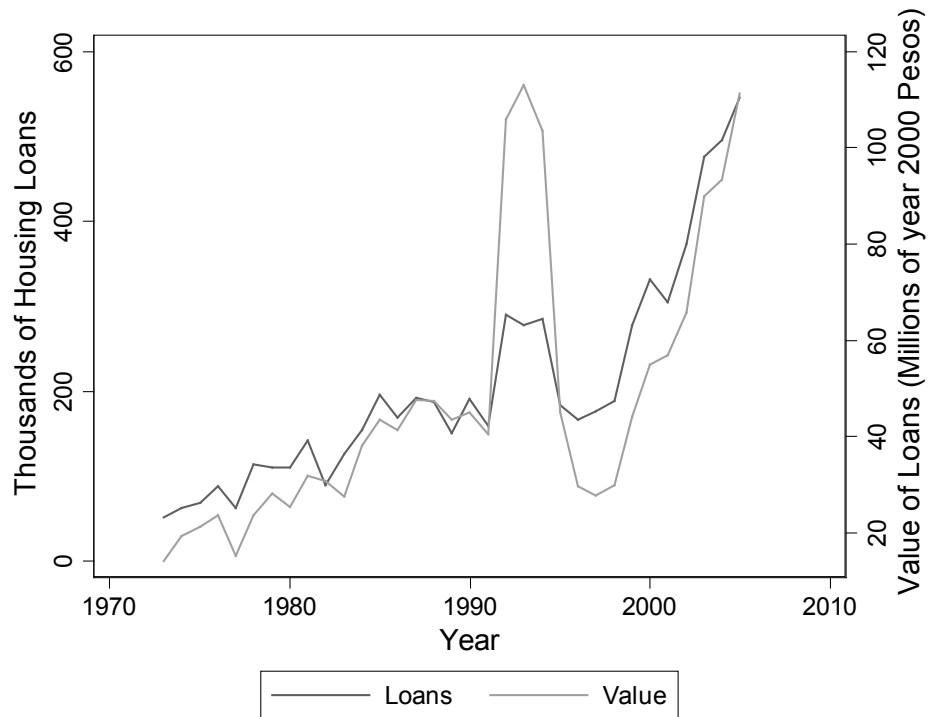
Source: CONAVI (nd).

Figure 2.1 Number and Value of Loans for Consolidated Houses, 1973–2005

Figure 2.1 shows the volume and value of loans issued in Mexico from 1973 to 2005 using data from the CONAVI database. The lending peak from 1991 until the crash of 1994 is extremely evident, especially in lending value. This huge expansion in housing finance was driven by the liberalization of banks in 1991, and almost two-thirds of the lending volume during this peak came from private banks. Figure 2.1 also shows the rapid growth in lending from 1997 onward, which surpassed pre-crash levels around the year 2000. The lag in lending value from 1994 until recently reflects the fact that the private sector, which makes larger loans than government lenders, still had not reentered the market.

In addition to lending for consolidated housing units, most government lenders provide loans for initial housing units,[3] housing improvement, infrastructure, and refinancing. Table 2.1 shows the number and value of loans issued by purpose from 1995 to 2005. A large share of loans was issued for purposes other than completed housing units, notably for housing improvement, which represents 40 percent of lending by volume. However, loans for purposes other than completed housing made up only 5 percent of lending value. Because these loans have a relatively minor impact on access to new housing, the main concern of this paper, I have excluded them from further discussion. That said, I do not mean to minimize the importance of these loans to housing in Mexico. The poor condition of much of the housing stock, the low purchasing power of many sectors of Mexican society, and the incremental housing process that continues to provide shelter for a large percentage of the population mean that lending for improvement or initial housing is an essential part of the country's housing policy and should be expanded.

Table 2.1 Lending Volume and Value by Purpose, 1995–2005

Purpose	Number of Loans (Thousands)	Percent of Loans	Loan Value (millions of Pesos)	Percent of Value
Completed housing	3,520	53.7	648.0	94.9
Housing improvement	2,566	39.1	16.1	2.4
Initial housing	322	4.9	9.7	1.4
Infrastructure	91	1.4	2.5	0.4
Refinancing	61	0.9	5.8	0.9
Total	**6,560**	**100.0**	**682.1**	**100.0**

Source: CONAVI (nd).

[3] An initial housing unit refers to a plot of land with infrastructure and part of a house– a bathroom and one room, for example. This is a variation on the sites-and-services concept of assisted self-help.

2.3.2 The Lenders

Commercial banks have recently resumed mortgage lending in Mexico, yet their share of the market remains small. In 2005, bank lending accounted for 8 percent of volume and 20 percent of overall value. INFONAVIT continues to dominate the housing finance market, with almost 70 percent of loan volume and half of loan value in 2005. The remainder of mortgage lending is either directly or indirectly run by the government. Table 2.2 reports lending volume and value for the eight largest lending institutions during the decade between 1995 and 2005. A multitude of smaller institutions, most of which are supported by state or local governments, also offer housing finance programs.

Table 2.2 Lending Volume and Value by Lender, 1995–2005

Lender	Number of Loans (Thousands)	Percent of Loans	Loan Value (Millions of Pesos)	Percent of Value
INFONAVIT	2,265	64.4	375.5	57.9
SHF	537	15.2	91.1	14.1
FOVISSSTE	336	9.5	62.0	9.6
Banks	129	3.7	70.5	10.7
INVI	73	2.1	5.8	0.9
PEMEX	25	0.7	8.3	1.3
C F E	19	0.5	4.3	0.7
SOFOLES	18	0.5	10.8	1.7
Other	118	3.4	19.8	3.1
Total	**3,520**	**100.0**	**648.1**	**100.0**

Source: CONAVI (nd).

The SHF appears in Table 2.2 as the second largest lender, with 15 percent of lending volume between 1995 and 2005 and 14 percent of value. It bears clarification that the vast majority of SHF lending is done through the SOFOLES. Thus, although the presence of the SOFOLES seems very small, accounting for 1 percent of lending volume and 6 percent of value in 2005, this refers to their origination of loans with securitized funds, and they will shortly take over management of SHF monies. The SHF also runs a subsidy program, Prosavi, which is similar to the Chilean model of housing subsidy, a one-time demand-side subsidy for new home buyers (Malpezzi 1998).

The lender INVI listed in Table 2.2 is the Housing Institute of the Federal District – the central area of Mexico City. INVI is the largest of state government lenders, although the Federal District is technically not a state and makes loans to residents of the Federal District with families of more than four, who meet certain income requirements and do not already own property. *Petróleos Mexicanos* (PEMEX), the Mexican national oil company, and the Federal Electricity Commission (CFE), the national energy company, both have significant housing finance programs for employees, similar to INFONAVIT or FOVISSTE.

2.3.3 Changes in Housing Stock

Changes in the quality of housing stock in Mexico are documented here, using microdata from the general census of population and housing. The 2000 census was the first to record the age of housing units in Mexico. An indicator of the age of a house is important

when analyzing housing quality in developing countries because houses are consolidated over time, thus older houses are more likely to be built of permanent materials though they started out without them. Yet the housing transition in Mexico is not in the existing stock; rather, it is the share of new housing that is built with permanent materials and infrastructure from the beginning. Thus, the overall share of houses that have permanent materials and infrastructure does not indicate the proportions that are built in this way. Even if the share of new houses built as finished units remains constant, the overall share of stock with permanent materials and basic infrastructure will grow over time.

Table 2.3 shows the percentage of all urban housing in Mexico that is built of permanent materials and has access to basic infrastructure. Data for 1980 were destroyed in the Mexico City earthquake in 1985. Between 1970 and 1990, not only did he housing stock almost quadruple, the quality was improved by a huge amount. Shortly after 1990, a majority of housing in Mexican cities was built with permanent materials had access to infrastructure. However, much of this housing is has been consolidated over time. This is made evident in Table 2.4, which shows for the year 2000, the number and percentage of houses in urban areas that were built with permanent materials, had access to basic infrastructure, or both, by the year built. A larger share of older housing is built with permanent materials and has access to basic infrastructure than new housing, due to the incremental development process by which housing is developed in Mexico.

Table 2.3 Urban Housing with Permanent Materials, Infrastructure, 1970-2000

Year	Number of Houses (Millions)	Permanent Materials (%)†	Infrastructure (%)††	Both (%)
1970	3.4	13.9	10.4	8.7
1980†††	NA	NA	NA	NA
1990	12.3	72.0	58.8	49.7
2000	17.4	81.2	67.8	60.6

Source: IPUMS (2008).
† Defined in 1970 as walls of brick or stone, floors of cement or other permanent material, and roofs of concrete or tiles of unspecified type. Defined in 1990 and 2000 as walls of brick, block, stone, cement, metal, or asbestos sheet; floors of cement or other permanent material; and roofs of masonry, concrete, clay tile, tiles of unspecified type, metal, or asbestos.
†† Defined as having electricity, a sewage system or septic tank, and a water supply piped exclusively to the household.
†††Data for 1980 were destroyed in the 1985 Mexico City earthquake.

In order to establish the rate of change in the share of new housing being built as a consolidated product is increasing, it would be ideal to compare housing built from 1995 to 2000 in year 2000 data with housing built from 1985 to 1990 in year 1990 data. Unfortunately, data limitations make this impossible. Nevertheless, the share of *all* urban housing with both permanent materials and basic infrastructure in 1990 is roughly the same as that of urban housing built between 1995 and 2000 in the year 2000 (49.7 and 47.1 percent, respectively), and the share of new housing that is consolidated in 2000 is far lower than the share of *all* urban housing in 2000 that is consolidated (60.6 percent), it is clear that the proportion of new housing built as consolidated units increased rapidly during the 1990s. Considering that nearly half of the houses built between 1995 and 2000 were built as consolidated units, it is most likely that the early in the first decade of the 21st century the majority of new houses are built in consolidated form in Mexico.

Table 2.4 Urban Housing with Permanent Materials, Infrastructure, or Both, by Year Built, 2000

Year House Built	Number of Houses (Millions)	Permanent Materials (%)†	Infrastructure (%)††	Both (%)
Before 1990	10.5	82.4	73.6	64.9
1990–1995	3.6	83.4	65.7	60.5
1995–2000	3.3	74.6	51.9	47.1

Source: IPUMS (2008).

†Defined in 1970 as walls of brick or stone, floors of other permanent material, and roofs of concrete or tiles of unspecified type. Defined in 1990 and 2000 as walls of brick, block, stone, cement, metal, or asbestos sheet; floors of cement or other permanent material; and roofs of masonry, concrete, clay tile, tiles of unspecified type, metal, or asbestos.

†† Defined as having electricity, a sewage system or septic tank, and a water supply piped exclusively to the household.

2.3.4 Connecting Housing Production to Housing Finance

According to data from CONAVI, a total of 1.32 million loans for completed housing units were issued from 1995 to 1999. During the same period, 1.55 million consolidated housing units were built according to census records. In order to more closely assess the connection between lending and building, data are compared at the metropolitan level for 128 metropolitan statistical areas (MSAs) in Mexico. The Mexican government defines as metropolitan statistical areas only those urban areas that encompass more than one municipality,[4] thus many large cities are not considered MSAs. For the purposes of this study, 128 MSAs were identified. These include the 55 MSAs defined by the Mexican government (SEDESOL et al 2004), which encompass 253 municipalities, and 73

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[4] Municipalities in Mexico are equivalent to counties in the United States. Mexico has no equivalent to incorporated cities.

additional municipalities, identified as MSAs using the United States definition (municipalities with an urban core of more than 50,000 people). These 128 MSAs are home to 65.3 million people, two-thirds of the country's population.
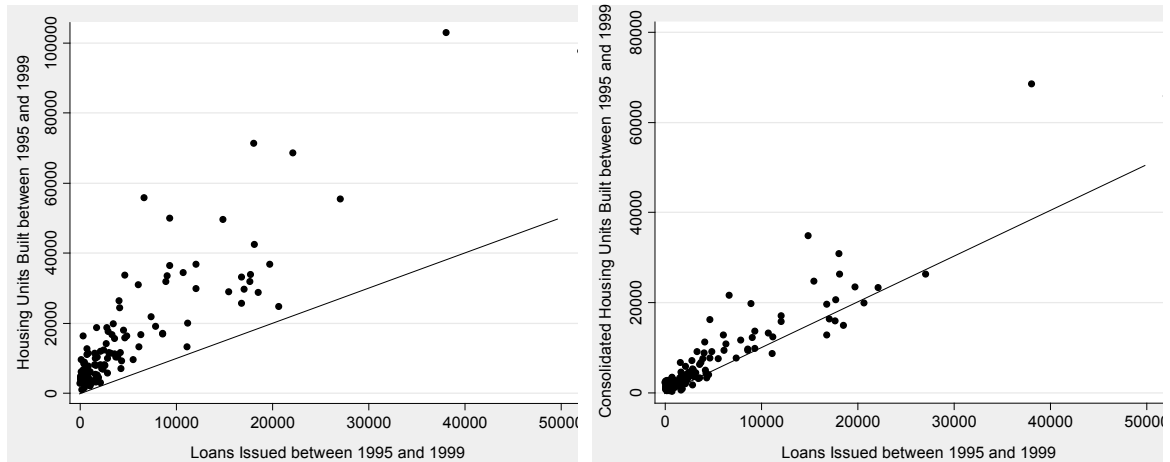
Source: IPUMS (2008) and CONAVI (nd).

Figure 2.2 All Houses and Consolidated Houses Built and Loans Issued in 127 Mexican MSAs[5], 1995–1999

The relationship between lending and new housing construction at the metropolitan level is close. The correlation between the number of houses built from 1995 to 1999 and the number of loans issued during the same period is 0.82 at the metropolitan level and the correlation between new consolidated houses and lending is 0.89. Scatter plots of lending and new houses, and lending and new consolidated houses built during the second half of the 1990s are shown in Figure 2.2. The large difference between the number of new

[5] This figure excludes the Mexico City Metropolitan Area because it is an extreme outlier – between 1995 and 2000 more than 640,000 houses and 300,000 consolidated houses were built, and 140,000 loans issued.

houses and loans issued in many MSAs demonstrates the continued importance of incremental housing production in most urban areas in Mexico.

The more accurate assessment of the relationship between housing construction and mortgage lending is found in the scatter plot on the right, as housing that is not consolidated is not eligible for purchase with a mortgage. It is not surprising then that the correlation between new consolidated housing and lending is higher than that between lending and all new housing. Nor it is surprising that the difference between the number of consolidated houses built and loans issued in a given MSA is smaller than that between loans and all new houses. The fact that the number of consolidated houses exceeds the number of loans issued in the majority of MSAs indicates that many houses continue to be built without financing or are financed informally by friends and family.

2.4 Implications of Restricted Access to Housing Finance

Housing finance in Mexico is available primarily to salaried employees. All salaried employees of private sector employers are required to pay a 5 percent payroll tax to the National Housing Fund (Diario Oficial de la Federación 2006a), from which their employees may borrow given a set of eligibility requirements, such as amount paid in, income, and family size. Government employees, including employees of nationally run companies and the military, have separate housing finance programs that are structured in a similar way. Additionally, the vast majority of loans from government lenders can only be used to purchase new houses that meet a set of requirements; permanent materials

used in roof, floor and walls, access to water, electricity and sewage, as well as having at least one bedroom. The combination of the two sets of restrictions on government housing loans, have consequential impacts on the housing conditions of salaried versus non-salaried workers, as well as implications for regional development in Mexico.

2.4.1 Household Implications of the Mortgage Lending System

Salaried workers have a strong incentive to make use of housing loans because they are mandatory contributors to one of several government housing finance funds and are able to obtain a loan at below market interest rates. Mortgages are issued only for consolidated housing, thus it is hypothesized that salaried employees will be more likely to live in consolidate units. Unfortunately, it is not possible to explore a complete model of housing choice because information on whether a household moved recently is not recorded in the census in Mexico. Nevertheless, census data do indicate the age of a housing unit. Thus it is possible to isolate households that live in newly built units, who by definition have recently moved, and within these households compare the housing conditions of those with and without access to finance.

The housing conditions of households that live in newly built houses, with salaried and non-salaried household heads are compared with two methods: logistic regression and a non-parametric matching procedure. As with all attempts at causal analysis, the goal is to isolate the effects of a household's access to credit from all other confounding variables. With any statistical method, we will have to assume that the differences between

households with salaried and unsalaried heads can be accounted for by observable characteristics. The most important of potentially confounding unobserved variables is a household's taste for housing. If it is the case that households who understand the housing benefits incurred by having a salaried job make an extra effort to obtain one, this would confound any non-experimental analysis. Isolating households to those that have moved into a newly built house reduces the possibility of this type of selection bias in the present case. Furthermore, recent theoretical advances in statistical matching methods (Abadie and Imbens 2002, 2006; Imbens 2004) greatly facilitate efforts to attenuate selection bias in this type of analysis. Although mostly used in relation to labor market policies (Dehejia and Wahba 1999); Heckman, Ichimura, and Todd 1997) matching methods have begun to be employed in empirical work from a variety of social science fields (Morgan 2001; Imai 2005; Sweeten and Apel 2007).

The matching technique is used to simulate a controlled experiment by matching subjects in a treatment group to those in a control group on all relevant characteristics after the fact, and then compare the outcomes for the two groups. In this case, salaried employment is considered as a treatment and households whose head has a salaried job are compared to those that do not. Matching techniques can be more useful than standard parametric estimation of effects because they do not impose a functional form on the model and it can be insured that controls are similar to treated group, however as suggested by Brady and Hui (2006), a combination of techniques is generally best.

Data on homeowner households are from the public use microdata sample of the long form of the 2000 general census of population and housing (IPUMS 2008). The analysis is conducted on a city by city basis, for the 51 cities with population greater than 250,000. Limiting the analysis to these cities ensures that there is a large enough number of households with a household head that is 'at work' and who live in houses built between the years 1995 and 2000 for a statistical analysis. Table 2.5 presents summary statistics for the mean values of selected characteristics of these households, comparing householders with and without salaried employment. Access to health insurance is used as a proxy for salaried employment, as employers are required by law to insure salaried employees with the Mexican Institute of Social Security (Diario Oficial de la Federación 2006b). Although it is possible to purchase insurance privately, it is not common.

Table 2.5 Selected Household Attributes for Owners of New[†] Houses in 51 MSAs in Mexico

Household Attributes	Salaried Job		Non-Salaried Job	
	Mean	St. Dev.	Mean	St. Dev.
Consolidated house (%)	62.66	14.59	61.11	15.35
Household income[††]	6,580.92	1,515.38	6,451.18	1,488.91
Age	35.83	1.61	35.91	1.65
Years of school	10.56	0.80	10.44	0.80
Household size	4.07	0.16	4.08	0.16
Male headed (%)	88.95	3.29	88.88	4.00
Indigenous (%)	4.02	6.29	3.98	6.46
Migrant (%)	5.14	3.51	4.80	3.17

Source: IPUMS (2008).
[†] Built between 1995 and 2000.
[††] In year 2000 pesos per annum.

In most cities of course, the means are as close as those reported in Table 2.5. In addition to the above variables, models include fixed effects dummy variables for the industry of employment[6] as well as the class of worker[7]. First, for each city, I estimate a logistic regression of the following form:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \beta_3 X_{3,i}$$

Where p_i indicates the probability of a household inhabiting a house built of permanent materials with infrastructure, X_1 is the matrix of householder characteristics, i.e. the log of age and years of school, whether they are male, indigenous or a recent migrant, X_2 is the matrix of household characteristics, i.e. the log of household income and the number of persons in the household, and X_3 is a matrix of fixed effects dummy variables indicating the industry and class of employment of the householder (white and blue collar workers in manufacturing are set as the base group).

The proxy for salaried employment is a statistically significant ($p<0.05$) determinant of whether or not a household lives in a consolidated house, controlling for other indicated variables, in 48 of the 51 cities analyzed. Figure 2.3 reports frequency distributions of the logistic coefficients and odds-ratios for the 51 cities. The average odds-ratio 1.9 with a standard deviation of 0.6, meaning that on average; otherwise similar households are almost twice as likely to live in a consolidated house if the householder has a salaried job.

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[6] Industries are: agriculture, mining, manufacturing, construction, commerce, hotels and restaurants, transportation, financial services, real estate and business services, public administration, and defense, public utilities, education, health and social work, community and other personal services, private household services.

[7] Classes of workers are: employer, independent contractor, day laborer, white and blue collar and unpaid family worker.
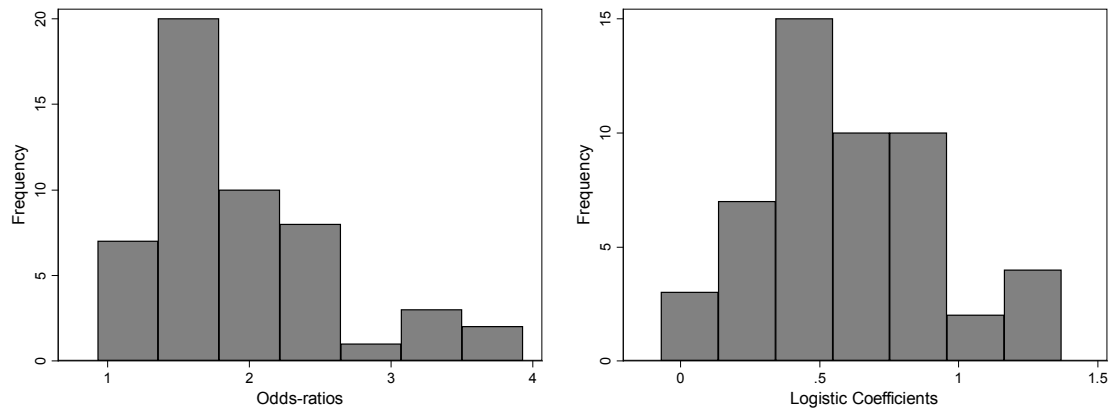
Figure 2.3 Distribution of odds-ratios and logistic coefficients for salaried employment proxy, 51 cities

In order to more directly assess the housing quality difference between households with salaried and non-salaried household heads, I calculate the difference in probability of owning a consolidated house for otherwise equal households with and without the proxy for salaried employment. The mean probability of owning a house (for the base group of the analysis, white and blue collar workers in manufacturing) is 0.35 and for those households with salaried employment it is 0.54. The frequency distribution of the difference between the two at the city level is shown graphically in figure 2.4. It has a mean of 0.19 and a standard deviation of 0.14. This difference is conceptually similar to the sample average treatment effect that will be estimated in the following section.
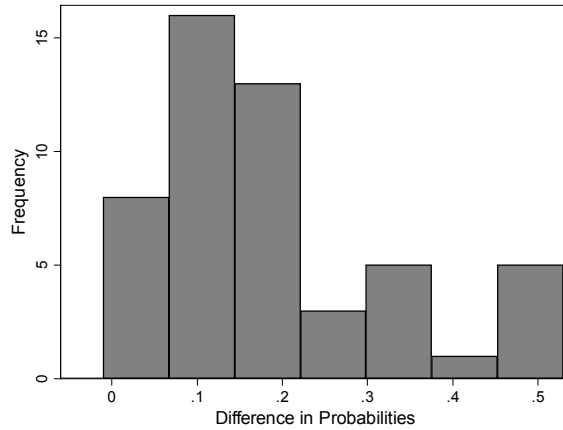
Figure 2.4 Difference in Probabilities of Owning a Consolidated House between Salaried and Non-Salaried Workers, 51 cities

A more accurate method to assess the difference in housing conditions between households that live in new houses with salaried and non-salaried household heads is using a matching estimator. In this section, households with salaried and non-salaried household heads are matched using the nnmatch program in Stata, which is a nearest-neighbor covariate matching estimator (Abadie, Drukker, Herr, and Imbens, 2001). There are several advantages to using this type of treatment effect estimator. It reduces bias because it allows for closer matches on covariates, providing the option of exact matches (Abadie and Imbens 2002). Furthermore, it allows for sampling with replacement and the use of multiple matches to ensure the full use of available information. Finally, it has the option of bias adjustment, which adjusts for the difference within matches using variation in their covariates (Chin, Fan, Imbens and Perloff 2006).

An important consideration in matching is to assess the overlap between treated and untreated groups in terms of the covariates. To ensure that good matches between

individuals from the two groups are possible, the two groups must have sufficient overlap of covariates. Although inspection of the distribution of covariates in this case and the summary statistics in Table 2.5 show high degree of overlap, an additional technique is employed to ensure overlap. Propensity scores are generated for each observation, and those observations with propensity scores of greater than 0.9 or less than 0.1 are excluded (Imbens 2007).

Sample average treatment effects of salaried employment were estimated for the 51 cities in Mexico with a population over 250,000 in the year 2000. Households were matched on the right-hand side variables used in the logistic regression above, and an exact match was required on the logs of household income, and the age and years of education of the household head. Conservative options were chosen in the matching estimation. Estimates were obtained using one and four matches. Using four matches smoothes the results by ensuring that maximum information is used (Abadie and Imbens 2002). Additionally, robust standard errors are calculated and the bias adjustment option was selected using all variables to correct for bias. Figure 2.5 reports the frequency distribution.

Although the distribution of the sample average treatment effects differs significantly when using one or four matches, both yield similar means, about 0.1, with a standard deviation of 0.7. In the estimation with 1 match, 46 of the 51 cities have effects that are statistically significant ($p < 0.05$), while in the estimation with 4 matches, there are 48. These correspond to the 48 cities with statistically significant coefficients for the proxy for salaried employment in the logistic regression.
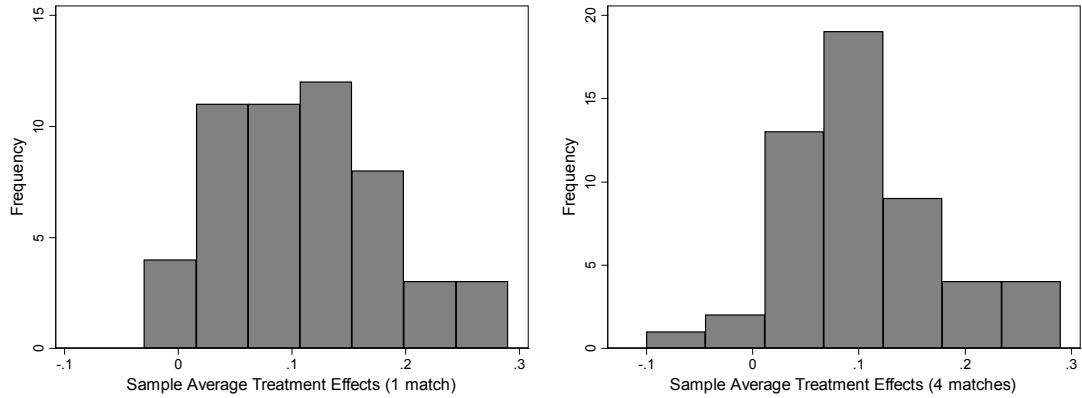
Figure 2.5 Distribution of Sample Average Treatment Effects (one and four matches) of Salaried Employment on Housing Quality, 51 Cities

Matching estimation yields results that are similar, but show slightly smaller effects as compared to the logistic regression. Nevertheless, the two are highly correlated (Spearman correlation coefficient of 0.58) and both show that having access to the finance system in Mexico impacts a households housing condition greatly. It increases the probability of living in a consolidated house, one with permanent materials and access to infrastructure, by between 10 and 19 percent on average, and up to 30 percent in some cities.

2.4.2 Regional Implications of the Mortgage Lending System

The structure of the mortgage allocation system in Mexico functions as a *de facto* industrial and regional development policy. INFONAVIT allocates loans in different income brackets to state offices based on the number of subscribers, i.e. salaried employees, who are eligible in a state. State offices then make loans available to new housing developments and eligible subscribers on a first-come first-served basis. Thus,

lending is channeled to places with large and growing numbers of salaried workers. The strong connection between salaried employment and lending for housing means that industries with large numbers of salaried employees receive an implicit subsidy. The manufacturing industry is the most noteworthy in this regard, as it is the largest industry in the country with almost 20 percent of total employment in 2000 and has the largest share of salaried employment of any private industry; more than 60 percent as compared to tourism (44 percent) wholesale and retail trade (44 percent) or agriculture (15 percent). Regional differences in industrial composition, employment growth, and the share of salaried jobs mean that the rate of lending will differ significantly by region. Table 2.6 reports the median levels of a series of MSA indicators for the 6 regions in Mexico. The two northern regions clearly stand out in terms of the number of housing loans issued per 1,000 new residents, the share of employment that is salaried, median household income and the location quotient of manufacturing employment. Meanwhile, the cities in the south of the country received the lowest number of loans per 1,000 new residents although they had an average share of salaried employment, although they did have a lower median household income and location quotient of manufacturing employment.

Table 2.6 Median Values of Selected MSA Indicators by Region

Indicators	Pacific	ZMCM	Center	Region Northeast	Northwest	South
Number of Cities	20.00	18.00	19.00	15.00	24.00	32.00
Loans per 1,000 New Residents, 2000–2005	22.30	23.50	22.00	40.40	42.50	17.20
% Job Growth, 1999–2004	31.80	-11.10	28.00	7.40	24.10	17.00
% Pop. Growth, 2000–2005	7.30	9.90	6.20	11.60	8.80	7.20
% Jobs Salaried, 2000	46.50	42.50	48.50	64.70	61.40	45.30
Median HH income, 2000	3,803.00	3,215.00	3,246.00	5,143.00	4,479.00	3,000.00
LQ Manuf., 1999†	0.65	1.15	0.90	1.30	1.12	0.48

Source: IPUMS (2008); CONAVI (nd); Instituto Nacional de Estadísticas, Geografía e Informática (1999 and 2004).
†Location Quotient (LQ) is defined as the share of jobs in manufacturing in a MSA relative to the share of jobs in manufacturing in all MSAs.

In order to visualize the regional differences in housing investment that result from the structure of the mortgage lending system, per capita housing investment from 1995 to 2004 by municipality is depicted on two choropleths in Figure 2.6; a standard choropleth of a map of Mexico divided by municipal boundaries and a cartogram. A cartogram is a map in which the size of aerial units corresponds to the magnitude of a selected variable rather than the actual geographic size. In this case, municipalities are scaled by population size, so that municipalities with very small populations are not overrepresented visually. The most outstanding change between the two maps is in the area occupied by the Mexico City Metropolitan Area.

The support for development of urban areas with large shares of manufacturing employment, which lie predominately in the north of the country, represents a shift in a regional investment and regional development policy in Mexico, which traditionally favored Mexico City over other areas (Garza 1985). On the one hand, the move away from support for housing in Mexico City is in agreement with (Secretaría de Desarrollo Social 1995). On the other hand, directing of funds to the north of the country and not to the far less developed southern states runs against a chief goal of the National Urban Development and Land Use Program of the Fox administration (2001–2006), that of reducing the severe regional inequalities in Mexico (Secretaría de Desarrollo Social 2001). In fact, the level of investment was one of the proposed indicators for measuring the extent to which the challenge of equitable regional development was met, which seems not to be the case in terms of housing.

Housing Investment, 1995-2004
(thousands of pesos per capita)
- 0
- 0 - 1
- 1 - 10
- 10 - 30
- 30+

Housing Investment, 1995-2004
(thousands of pesos per capita)
- 0
- 0 - 1
- 1 - 10
- 10 - 30
- 30 +
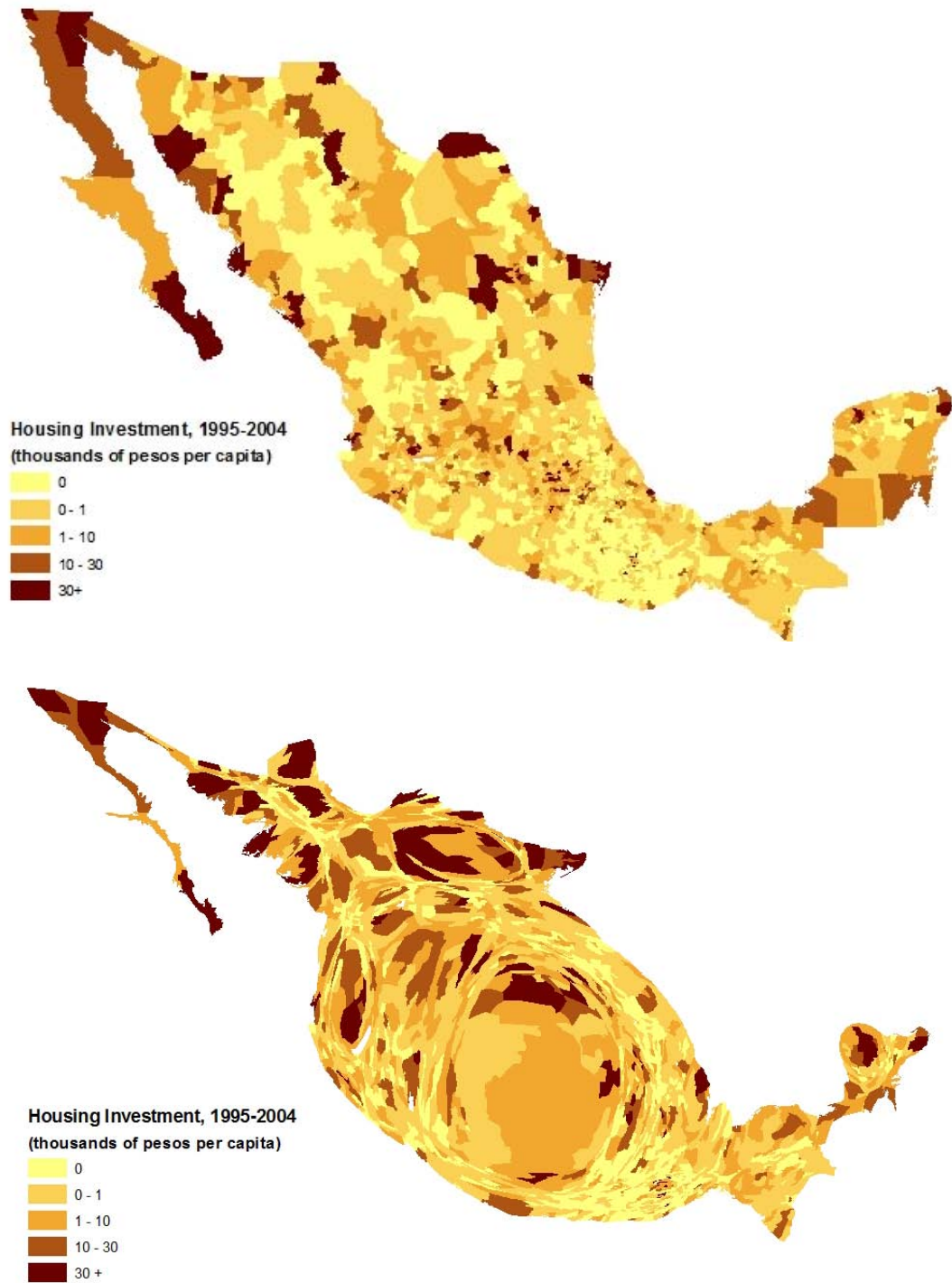
Source: Author, with data from CONAVI (nd); IPUMS (2008); and INEGI (2000b).

Figure 2.6 Housing Investment per Capita by Municipality, 1995–2004

2.5 Conclusion

The housing finance system in Mexico today is dominated by government lenders, especially INFONAVIT, and the principal eligibility requirement these lenders impose– formal, salaried employment–has several impacts. Firstly, households with an eligible head are more likely to live in new, consolidated housing than other similar households. Thus, cities with more formally employed, salaried workers receive larger shares of loan volume and value than otherwise similar cities. Regionally, this means that housing finance supports the trend of population migration to cities outside of Mexico City, especially those in the north, which have larger shares of salaried, manufacturing employment.

The findings presented here are important in establishing the fundamental role reform of the housing finance system played in the housing transition in Mexico; a shift from the production of housing informally and incrementally to one in which consolidated housing is built by the private sector and purchased with financing. However, the impact of the lending restrictions of the housing finance system is just one example of the broader research perspective needed in Mexico. The impacts of the quasi-market structure of the new homebuilding system extend across spatial scales (house, city, and country) and policy sectors (urban, social, and industrial) thus must be studied and understood accordingly.

Careful research is also needed to address the growing debate over the houses and neighborhoods produced by the new system. All urban growth generates problems, thus it is essential to understand what aspects of housing policy are contributing to observed problems and which of these are ameliorable. Housing policy is a world of second bests, rife with market failure and under defined distributional objectives on the part of the government (Whitehead 1991). Precisely because of this, analysis and debate of housing policy must be based on evidence (Mclellan and More 1999). The impact of the new high-density housing developments, their homogeneity, or the lack of access to urban amenities must be considered against realistic alternatives rather than normative ideas of what housing should be. Problems with new housing developments must be clearly identified and attempts made to determine their sources–whether they result from attempts to make housing affordable, incomplete markets, or government restrictions. Far too frequently housing policy is made and evaluated based on ideological principles or visual symbols rather than careful, evidence-based analysis.

Chapter 3
The Reorganization of the Residential Construction Industry

3.1 Introduction

If housing supply continues to be understudied in developed countries a decade after the much-cited review of the topic by DiPasquale (1999), it is practically uncharted territory in developing countries. What research does exist generally focuses on self-help or informal construction practices or evaluations of subsidy programs. In Mexico, reform and expansion of government housing finance agencies that began during the 1990s have dramatically transformed the homebuilding industry, creating one in many ways similar to those found in developed countries. A majority of new houses are now built in large, speculative suburban developments by formal private sector companies and purchased with mortgages. Several national homebuilding companies have emerged, six of which are publicly traded.

Yet two significant differences between the homebuilding industry in Mexico and that of developed countries persist. First, a very large segment of the residential construction industry remains informal. Only a handful of residential construction firms are formally registered with the government in many metropolitan areas, when, in fact, a large number of homebuilders operate in the market, and even publicly traded homebuilding firms employ vast numbers of workers informally. Secondly, the vast majority of loans in the country are from government lenders, which issue mortgages in a centrally planned

manner supporting companies that build low-cost housing and favoring large-scale construction.

This paper analyzes the role that government housing finance plays in the changing industrial composition of the homebuilding industry in Mexico. After a brief review of literature on the industrial structure of homebuilding and background on the relationship between government housing finance companies and private sector homebuilders in Mexico, trends in residential construction employment are explored quantitatively. Then, I test a series of hypotheses regarding the impact of lending on builder size, market concentration, formal employment, and housing prices.

In spite of data limitations, several important stylized facts emerge from the analysis. Metropolitan areas in which a greater share of new houses were purchased with government mortgages have larger residential building firms and a greater share of formal employment in the construction industry. At the same time, these places tend to have a lower level of market concentration and lower housing prices, based on evidence from one of the largest homebuilding companies. Thus, although the direct government support for certain homebuilding firms has led to the rise of several large, national companies, it seems that it also promotes competition and leads to lower housing prices in metropolitan areas with large numbers of loans.

In providing empirical tests of relationships between government housing finance and the private residential construction industry, this paper makes two contributions to the

literature on housing supply. It is the first analytical treatment of the industrial organization of housing supply in a developing country, providing a glimpse at the evolution of a formal homebuilding industry. Secondly, it contributes to an apparent disagreement over the drivers of market concentration and firm size in North America. Previous studies of the homebuilding industry in Canada and the United States show that larger, more active housing markets have larger homebuilding firms; however, they disagree over whether size and market activity lead to greater market concentration. In this regard, Mexico resembles Canada more closely as large, active markets have less market concentration, unlike the United States where larger, more active markets are more concentrated.

3.2 Finance and the Industrial Organization of Housing Supply

The residential construction industry exists in a wide variety of forms in different countries (Ball 2003). In spite of its traditional classification within the model of a competitive industry, construction can actually be considered as a form of monopoly due to the nature of land. At any given place, the supply of land is completely inelastic, which gives a developer a highly localized monopoly. The systematic variation in market structure across metropolitan areas within the same country suggests that the industry is more consistent with product differentiation models (Somerville 1999). Residential construction firms generally specialize in a specific type of housing unit in a given market, which enhances their market power in any given city, offering further supports for the product differentiation model. A more complete discussion of the relevance of

product differentiation models to the homebuilding industry is provided in Somerville (1999), where, as in the present paper, it is used as theoretical motivation for differences in the organization of the residential construction industry across markets.

One of the chief factors preventing the emergence of a large-scale speculative homebuilding industry in developing countries is the lack of mortgage finance. Without adequate systems for the purchase of housing with financing, the speculative homebuilder often must provide its own financing for the purchase of units, severely stunting development. As Renaud (1987) argues, "methods of finance dictate modes of construction rather than the reverse." Thus, in most developing countries, the majority of housing is built incrementally by individual households. Families often occupy a piece of land first, erect a makeshift structure, and slowly make the structure more permanent, gaining access to infrastructure over time as they are able to save enough money.

In developed countries, the importance of mortgage finance, which generally depends greatly on direct or indirect government support, for the structure of the homebuilding industry is often taken for granted, though perhaps with the recent global financial crisis this will change. The mass production of social housing in mid-20th century Europe depended completely on government finance and tended toward large-scale construction in order to harness economies of scale (Balchin 1996). In the United States, the importance of government-guaranteed and insured credit in the emergence of large-scale homebuilder during the same time period is well documented. Scholars have also argued that the codification and standardization of minimum housing conditions for Federal

Housing Authority and Veterans Administration mortgages led to the profitability and rise of the mass production of housing (Maisel 1953; Herzog 1963; Eichler and Kaplan 1967).

The literature on the impact of mortgage finance systems on the organization of the homebuilding industry that is relevant to Mexico is limited; however, given the connection between mortgage finance and construction finance, literature that discusses the connection between construction finance and industrial structure is relevant. Theoretically, banks increase the availability of credit to small and midsized firms because they are able to reduce the informational asymmetry between lenders and borrowers (Diamond 1984). For example, Ambrose and Peek (2008) provide evidence that the health of local banks is significantly associated with the market share of public versus private homebuilders, with public companies share increasing as the health of local banks decreases. In Mexico, therefore, where bank financing is limited, larger firms will have an advantage in access to construction financing. Furthermore, because the success of a housing development also depends on the buyer's ability to secure mortgage financing for the purchase of the houses, a developer's ability to secure construction finance often depends on whether mortgage finance is in place once it is built. Thus, the preferential access to government loans detailed below is especially important.

3.3 Background on the Housing Transition in Mexico

The transformation of the Mexican homebuilding industry is evident in the peripheries of cities across the country – large developments of tract housing are being built at a rapid

rate, sprouting like fields of corn.[8] These new housing developments stand in sharp contrast to the traditional incremental form by which the majority of households in Mexico acquired housing. The primary driver of this emerging suburbia is the boom in housing loans, which grew from about 200,000 originations in 1997 to roughly 700,000 in 2007. The vast majority of mortgages come from a handful of government agencies, principally the Institute for the Foment of Worker Housing (INFONAVIT its acronym in Spanish), which use payroll taxes to fund loans.

Private banks in Mexico ceased lending for housing completely after the financial crisis of 1994, and government housing agencies became the only provider of mortgage funds in the country. Spurred by this change and an ideological shift towards free-market principals, the housing agencies of the Mexican government shifted out of their role as direct providers of housing to become purely financial institutions (Puebla 2002). However, government housing loans were for buyers with much lower incomes than those of the private banks, and at first, private homebuilders did not build sufficient numbers of low-cost units to meet lending goals. Previously, they had only built housing for middle- and upper-income groups because banks did not issue mortgages for low-cost housing. The lack of housing finance is a problem endemic to developing countries, stemming mostly from a lack of credible contracts due to weak or unenforced laws, relatively high administrative costs, and volatile inflation (Malpezzi 1990; Buckley 1996).

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[8] In excuse of the metaphor, laying the foundations for new housing developments in Mexico is referred to with the verb *sembrar*, or 'to plant'.

Thus, government lenders began adjusting their loan allocation systems to accommodate the needs of private builders and sought to convince homebuilders that building low-cost housing could be profitable by agreeing to support builders in a variety of other ways. The relationship between government lenders and private homebuilders was formalized in an agreement signed between the largest government mortgage lender, INFONAVIT, and private homebuilding firms represented by the Mexican Construction Industry Association in 1999. The Commitment to Housing codified cooperation and joint action between the two parties and covered several areas (Diario Oficial de la Federación 1999). INFONAVIT committed to providing homebuilders more information on the number and size of loans that would be available in any given metropolitan area[9] and to streamline the process by which houses were approved for purchase with its loans. INFONAVIT also put pressuring state and local governments to relax permitting processes and agreed to purchase units directly from developers once they were more than 65 percent complete (Cámara Mexicana de la Industria de la Construcción 1999; Pardo and Sanchez 2006). The agreement was a success, and the number of low-cost housing units grew in pace with the volume of loans.

Much of the growth in low-cost, formal housing units has been in large developments. The large-scale homebuilding companies in Mexico operate as a sort of speculative builder, but with a guaranteed market. INFONAVIT assures developers loans for units before they are built and the assignation of financing means that INFONAVIT members are channeled into buying them. In fact, INFONAVIT members who want to purchase houses actually go to the offices of INFONAVIT to look for housing opportunities, as

[9] INFONAVIT allocates loans to state offices based on the number of eligible subscribers in that state.

INFONAVIT maintains a database on eligible housing for sale. Though lending practices have become much more flexible recently, and it is now possible to use loans from INFONAVIT to purchase any house, used or new, the house still must fit a set of requirements – built of permanent materials; with access to electricity, water, and sewage, and at least one bedroom – that excludes many existing low-cost houses in Mexico.

The six publicly traded homebuilding firms in Mexico are truly large-scale builders, selling tens of thousands of units a year. Figure 3.1 shows the number of units sold by the six publicly traded Mexican homebuilding firms during 2005. The two largest builders have reached production numbers almost at the scale of large homebuilders in the United States, building more than 35,000 homes in 2005. In the same year, the two largest homebuilders in the United States, D.R. Horton and Pulte Homes, built 50,000 and 45,000 homes (Builder Magazine nd). Although the large-scale builders have not reached the scale of large U.S. builders, the market concentration of homebuilders in Mexico is larger. The concentration ratio, which is the share of construction from the four largest firms, was 14 percent in Mexico in 2005, compared to 9 percent in the United States (Builder Magazine nd; U.S. Census Bureau and Department of Housing and Urban Development 2005).
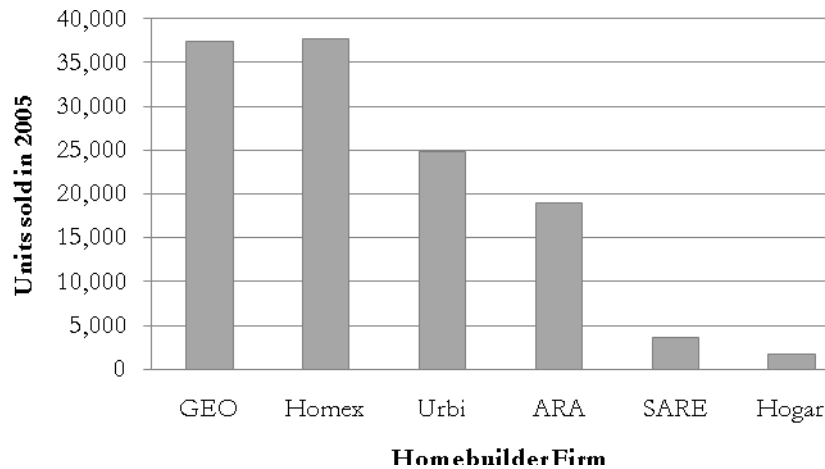
Source: Corporación Geo (2007); Homex (2005); Urbi (2007); Consorcio ARA (2005); SARE (2007); Consorcio Hogar (2005).

Figure 3.1 Housing Units Sold in 2005 by the Six Publicly Traded Homebuilders

Furthermore, like their U.S. counterparts, the large-scale homebuilders in Mexico are speculative builders and have also become some of the largest landowners in Mexico. The acquisition of land is a business strategy pursued by all of them. Based on figures in the annual reports referenced in Figure 3.1, I estimate that the six publicly traded homebuilding companies held almost 20,000 hectares of land reserve in 2005.

Finally, it is worth noting that the growth of residential construction in Mexico over the last decade stands in contrast to the fate of the rest of the construction industry in that country, which has suffered a series of crises since 1980 (Connolly 2007). Starting with the financial crises in 1982 and 1994, the construction industry in Mexico also suffered from the withdrawal of government funding for large construction projects and the shift toward competitive, open bidding for those projects. Reform of the bidding process for government-funded projects also led to the increased participation of construction firms

from the United States and Asia. Homebuilding is noteworthy in this respect also; though foreign capital has been channeled into the Mexican mortgage market, there is no significant presence of a foreign homebuilding company in Mexico. In fact, it is the Mexican homebuilders that have expanded operations abroad. Casas Geo has built housing projects in Chile and Texas (Corporación Geo, 1999).

3.4 Trends in Residential Construction Employment

In this section, employment trends in residential construction are documented. The principal source of data is the economic census of Mexico (Instituto Nacional de Estadísticas, Geografía e Informática 1989, 1999, 2004), which provides data from firm level surveys. In addition, employment data from the general censuses of population and housing from 2000 (Instituto Nacional de Estadísticas, Geografía e Informática 2000a) is referenced in order to provide a more complete picture of the industry.

Table 3.1 shows the number of employees in formal residential construction companies, the number of residential construction firms, the number of housing loans, and the money invested in housing in 1989, 1999, and 2004. The growth in the number of residential construction employees parallels that of mortgage lending in Mexico during this period, though the rate of change is much lower. Nationally, lending volume almost doubled between 1989 and 1999 and again between 1999 and 2004, while employment grew by only 11 and 37 percent during these periods. The recent growth in the sector is

noteworthy in that construction employment in other areas actually decreased during this period.

How should we interpret the large discrepancy between the rates of growth in mortgage lending and employment in residential construction? Did employees double productivity between 1989 and 2004? Though increased productivity might be responsible for some of the discrepancy, it mostly reflects the nature of data in the economic census, which does not record the large numbers of informal and temporary workers. For example, while roughly 640,000 jobs in the construction sector overall were recorded in the economic census of 1999, slightly more than 2.6 million people stated they were employed in the construction sector in the general census of population and housing of the year 2000. Thus, it seems that roughly three-quarters of employment in construction is off the books or temporary. Nor is informal employment restricted to small operations. Anecdotal evidence suggests that large homebuilding firms employ significant numbers of temporary workers as well. In a short description of the company for the Mexican stock exchange,[10] Casas Geo advertises that it has a full-time staff of more than 3,000 employees and as many as 25,000 day laborers at any given time.

[10] www.economia.com.mx/geo.htm (last accessed 02/01/2009).

Table 3.1 Employment in Residential Construction and Mortgage Lending, 1989 – 2004

Year	All Construction Employees	Residential Construction Employees†	Residential Construction Firms	Housing Loans	Housing Investment††
1989	342,406	146,805	2,242	150,079	43,421
1999	640,357	162,941	1,971	277,483	44,141
2004	635,840	223,148	2,672	496,052	93,482

Source: INEGI (1989, 1999 and 2004); CONAVI (nd).
†NAICS code 23611.
††In thousands of year 2000 pesos.

The large variation in construction employment figures from different sources is demonstrated clearly in a recent report on the construction industry in Mexico commissioned by the International Labour Organization (Connolly 2007). In it, Connolly triangulates data on employment in the construction industry from three sources. First, construction firms registered with the Mexican Chamber of the Construction Industry have the fewest recorded employees, roughly 230,000 in 1999. Second, the Mexican Institute of Social Security recorded 880,000 employed in construction in the same year. Finally, the national employment survey reported slightly more than 2 million construction employees in 1999. These numbers, like those from the economic and general census, demonstrate the prevalence of informal employment in the sector. Yet Connolly makes a further point. Not only are well-defined employment numbers difficult to find for the construction industry, they fluctuate from year to year due to the large number of temporary employees. The present analysis uses data from the economic census because it is the only source that provides data in firm-size categories.

Another important component of the discrepancy in growth rates during the 1990s and the first half of the 2000s observed in Table 3.1 is regional variation. While aggregate employment numbers grew during the 1990s and continued into 2004, there was actually a decline in residential construction employment in some states. While central and northern states such as Guanajuato, Aguascalientes, Durango, and Chihuahua saw increases of several hundred percent in residential construction employment, the metropolitan area of Mexico City lost 30 percent of jobs in the sector, mostly in large firms.

3.4.1 Data on Industry Structure

In examining data on employment and output of residential construction firms in the economic census, the homebuilding industry in Mexico appears to be highly concentrated. Table 3.2 presents the number of jobs and value of construction by firm size, along with shares of the total, for firms dedicated to residential construction[11] in the years 1999 and 2004. In 1999, roughly one-third of total employment was in firms with more than 1,000 employees, though this relative and absolute concentration decreased drastically over the next five years. In fact, the largest firms (more than 1,000 employees) were the only ones to lose employees during the early 2000s.

A more accurate way to assess the importance of firms by size is at the metropolitan level. Thus, the fourth and fifth columns of Table 3.2 present the average share of jobs by firm size at the metropolitan level.[12] These percentages show that when present, large firms tend to represent a very important share of overall employment. However, most cities do not have large firms, and in these cities, the distribution of employment over different sizes of firms is more even. Secondly, the share of jobs by MSA shows the trend away from extremely large firms toward large and medium firms was more pronounced at the metropolitan level. The largest two firm-size categories lost one-third of their average share of employment while some categories of small firms doubled their share of employment, and firms with between 50 and 250 employees increased by one-third.

[11] NAICS code 23611.
[12] Metropolitan areas in Mexico are defined by the author as per the definition used by the United States census bureau, municipalities within a commute shed of urban areas with more than 50,000 people. Although several definitions of metropolitan area exist in Mexico (Secretaría de Desarrollo Social et al. 2004), the US definition is used because the definition in Mexico excludes a large number of large cities.

Table 3.2 Employment and Value of Construction by Firm Size, 1999 and 2004

Firm Size (employees)	All Jobs		Mean % of Jobs by MSA		Value of Construction	
	1999	2004	1994	2004	1999†	2004†
1–10	3,115	3,225	10	13	6,450	2,941
11–15	2,575	4,263	12	20	834	2,903
16–20	2,266	4,157	11	23	407	1,639
21–30	4,196	8,534	14	31	992	3,102
31–50	7,521	12,528	20	25	1,748	4,071
51–100	13,684	24,812	22	29	2,755	7,216
101–250	25,129	47,589	30	42	3,990	10,718
251–500	27,957	42,679	38	36	3,766	8,684
501–1,000	20,902	31,487	45	33	2,463	6,098
1,001+	53,755	43,874	60	40	4,649	8,877
Total	161,100	223,148	NA	NA	28,054	56,249

Source: INEGI (1999 and 2004).
†Millions of 2004 pesos.

However, it is again important to note that the above data do not include the large numbers of informal or temporary employees in residential construction. This clearly excludes many firms, a point driven home when analyzing the data at a metropolitan level. In the economic census of 2004, for example, it appears that more than half of Mexico's 128 metropolitan areas, principally the smaller ones, had fewer than seven residential construction firms registered, which is extremely unlikely. For example, it is not possible that Orizaba, a city of 350,000 people that added almost 10,000 housing units between 2000 and 2005, had only four residential construction firms in 2004. Thus, in addition to the temporary and day laborers who work informally for established construction firms, informal employment also includes many construction firms not recorded in the economic census. Without any indication of firm size, this employment cannot be included the following analysis.

As a final note regarding data, analysis of the reorganization of the homebuilding industry would benefit greatly from two sets of data that are not recorded in Mexico. First, the lack of information on the size of new housing developments means that models that test whether the industry is competitive or has monopoly characteristics are necessarily based on the size of the building firms as proxy, as the development itself is the monopoly (Somerville 1999). Secondly, more complete data on national homebuilders, especially in regard to the location of their housing starts, would contribute to the discussion of industrial organization, especially in terms of market power.

3.5 Determinants of Firm Size and Concentration

In this section, I test the determinants of the variation in residential construction firm size and market concentration, with the central hypothesis that they are significantly influenced by the amount of mortgage lending in a given market. In addition, I test sub-hypotheses regarding the importance of market activity and land supply. Data are combined from several sources. In addition to employment numbers described above, housing counts for 2000 and 2005, new houses built between 1995 and 1999, the calculation of median household income, and the share of construction employment that is formal are based on the year 2000 general census of population and housing and the II count of population and housing of 2005 (Instituto Nacional de Estadísticas, Geografía e Informática 2000a and 2005). Data on MSA size and the supply of developable land are taken from the National Land Inventory of the Secretariat of Social Development (Secretaría de Desarrollo Social 2002) and data on lending are provided by the National Housing Commission (Comisión Nacional de la Vivienda, nd). Table 3.3 provides a summary of the variables used.

As discussed in similar work in Canada and the United States, the ideal dependent variable in this analysis would be the number of firms categorized by the number of units produced annually; however, the dependent variables used – mean firm employment and value of construction – are the best proxy variables available (Somerville 1999; Buzzelli 2004). Observations are MSAs as defined previously. In order to construct the firm size and concentration measures, some assumptions were made. Data are reported by the

number of employees in the firm size categories listed in Table 3.2. The number of employees was divided by the midpoint of the size category and summed over categories to obtain an estimated number of firms. The total number of employees and construction value in an MSA was then divided by this estimate of firms to obtain the mean firm size and construction value.

Table 3.3 Summary Statistics of Selected Variables

Variable	Mean	Std Dev	N
Mean # of employees, 1999	78.2	104.1	106
Mean # of employees, 2004	64.8	55.2	115
Mean value of construction, 1999 (000,000,000s of 2004 pesos)	7.1	8.1	106
Mean value of construction, 2004 (000,000,000s of 2004 pesos)	14.0	13.8	115
Concentration ratio, 2004 (cr4)	57.1	17.9	54
New houses, 1995-2000 (000s)	23.5	66.5	128
New houses, 2000-2005 (000s)	17.1	43.9	128
% of new hsg. financed, 1995-1999	23.6	16.4	120
% of new hsg. financed, 2000-2004	68.7	58.9	122
MSA size, 2000 (000s of hect.)	10.0	20.4	128
Developable land, 2000 (000s of hect.)	4.2	7.5	118
Median household income, 2000 (000s of 2000 pesos)	3.9	1.6	128
% of construction employment formal	32.1	14.2	120

Source: INEGI (1999, 2000a and 2004); CONAVI (nd); SEDESOL (2002).

The concentration index, CR4, indicates the share of construction employment in an MSA in the four largest construction companies. It is measured only for the metropolitan areas with a population of more than 100,000 and more than seven residential

construction firms (fifty-four MSAs in 2004 and forty in 1999). As mentioned previously many metropolitan areas record very few jobs or firms in residential construction in the economic census. This highlights a potential for bias in the present analysis. Large levels of informal employment in residential construction in unrecorded small firms would bias mean firm size and market concentration measures upward. Given the association between small firms and informality, it might be assumed that informal employment in construction is more prevalent in small firms. However, anecdotal evidence on one large firm reported earlier as well as a report from the International Labour Organization (2001) suggests that construction firms registered with the Mexican Chamber of the Construction Industry employ more than two-thirds of their work force informally. Thus, it cannot be assumed that the lack of data on informal employment will bias the analysis one way or another.

First, simple OLS log-linear reduced form models are run with five different dependent variables; the log of mean firm size in 1999 and 2004, the log of mean value of construction by firm in 1999 and 2004, and the measure of market concentration, CR4, in 2004. A model of the concentration ratio in 1999 yielded no significant coefficients and thus results are not reported. As control variables, models include the logs of MSA size, hectares of developable land as defined by a municipal development plan, median household income, the growth in housing units in the five-year period previous to the data on residential construction, and fixed effects dummy variables for the regions of Mexico. Table 3.4 shows the results of these regressions. All models are statistically

significant as demonstrated by the F statistic and White robust standard errors are used due to minor heteroskedasticity.

Results in Table 3.4 show that controlling for market size and land supply, mean firm size and mean value of construction are significantly influenced by both overall construction activity and the volume of lending as a share of new housing built to similar degrees. In fact, in both 1999 and 2004, the share of new housing purchased with a loan was the most important determinant of both mean firm size and mean value of construction. In 1999, the coefficient is quite large; for every 10 percent increase in the share of new houses that were purchased with mortgages, residential construction firms were 24 percent larger and had a 20 percent larger value of output on average. The importance of lending decreases in 2004, though it continues to be an important determinant.

Land supply is only a significant determinant of mean firm size and mean value of construction in the models for 1999, in which it has an elasticity of 0.32 and 0.26, respectively. Logically, cities with more readily available land are more likely to have larger firms. Market activity was a significant and important determinant of mean firm size and mean value of construction in 2004. For every 10 percent increase in the number of new houses added in a metropolitan area between 2000 and 2005, residential building firms were 2.8 percent larger and had a 5.1 percent larger value of production. In both 1999 and 2004, the median household income had a significant and highly elastic impact on the mean value of construction by firm.

Table 3.4 OLS Regression Results: Determinants of Builder Size and Concentration, 1999 and 2004

Variables	1999		2004		
	In(size)	**Ln(value)**	**In(size)**	**In(value)**	**CR4**
ln(MSA size)	-0.437 [0.303]	0.041 [-0.271]	0.030 [-0.185]	-0.193 [-0.254]	0.029 [-0.055]
ln(hectares of developable land)	0.327 [-0.149]**	0.263 [-0.154]*	0.029 [-0.148]	0.066 [-0.187]	0.025 [-0.026]
In(Median HH income, 2000)	0.281 [-0.541]	0.854 [-0.443]*	0.294 [-0.474]	0.905 [-0.502]*	0.314 [-0.124]**
In(New houses 1995-1999)	0.340 [-0.319]	0.206 [-0.259]			
% of new hsg. financed, 95-99	2.361 [-0.736]***	1.988 [-0.623]***			
In(New houses 2000-2005)			0.278 [-0.155]*	0.511 [-0.194]***	-0.170 [-0.059]***
% of new hsg. financed, 00-05			0.537 [-0.182]***	0.709 [-0.204]***	-0.116 [-0.055]**
Constant	-1.167 [-3.899]	-3.570 [-3.344]	-2.146 [-3.699]	-2.757 [-4.069]	-0.867 [-0.960]
Observations	99	98	103	102	52
R-squared	0.27	0.38	0.28	0.40	0.58
Adj. R-squared	0.19	0.30	0.21	0.34	0.48
F	3.32	5.25	7.00	7.47	7.58

Notes: White robust standard errors in brackets. ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels. Coefficients from region fixed effects not reported.

In the model of market concentration in 2004, both overall housing construction activity and the volume of public lending as a share of new housing had significant *negative* coefficients. The impact of overall residential construction was slightly greater, with an elasticity of -0.17 as compared to that of the share of new housing purchased with financing -0.12. Additionally, the median household income has a large and significant impact on market concentration – for every 10 percent increase in median household income, there is a 3.1 percent increase in the share of employment concentrated in the four largest residential construction firms.

As discussed in similar work in the United States (Somerville 1999), there is a possible simultaneity bias between market activity and the size of builder firms and market concentration. The presence of larger firms could lead to more construction, in addition to more activity leading to larger firms. In order to account for this bias, two-stage least square (2SLS) regressions are run, with housing growth instrumented by the log of population in the year 1990 and 2000 and the log of job growth between 1989 and 1999, and 1999 and 2004. There is no possibility of endogeneity between industrial structure and lending volume because, as was mentioned previously, the number of government loans in a given metropolitan area depends not on demand, but on the number of salaried employees in a state. Table 3.5 reports the results of the five IV models.

Table 3.5 2SLS Regression Results: Determinants of Builder Size and Concentration, 1999 and 2004

Variables	1999		2004		
	ln(size)	ln(value)	ln(size)	ln(value)	CR4
ln(MSA size)	-0.204 [-0.306]	0.203 [-0.321]	-0.133 [-0.316]	-0.440 [-0.430]	0.066 [-0.058]
ln(hectares of developable land)	0.249 [-0.118]**	0.216 [-0.141]	-0.051 [-0.128]	-0.014 [-0.167]	0.009 [-0.028]
ln(Median HH income, 2000)	0.169 [-0.389]	0.673 [-0.316]**	-0.165 [-0.398]	0.038 [-0.452]	0.162 [-0.078]**
ln(New houses 1995-1999)	0.339 [-0.297]	0.192 [-0.318]			
% of new hsg. financed, 95-99	2.026 [-0.662]***	1.573 [-0.555]***			
ln(New houses 2000-2005)			0.519 [-0.266]*	0.886 [-0.353]**	-0.169 [-0.057]***
% of new hsg. financed, 00-05			0.766 [-0.250]***	0.916 [-0.282]***	-0.154 [-0.050]***
Constant	-1.617 [-2.992]	-3.019 [-2.412]	1.468 [-3.197]	3.957 [-3.677]	0.331 [-0.630]
Observations	96	95	100	99	51
R-squared	0.24	0.37	0.25	0.36	0.40
Wald chi-squared	46.29	65.74	32.11	61.64	31.64

Notes: White robust standard errors are in brackets. ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels. New houses from 1995-1999 is instrumented with ln(Population, 1990), ln(Job growth from 1989-1999) and 5 regional dummies. New houses 2000-2005 is instrumented with ln(Population in 2000), ln(Job growth from 1999-2004) and 5 regional dummies.

On the whole, results from the 2SLS specification do not differ greatly from the OLS models. Some coefficients are no longer significant or smaller. For example, land supply is no longer a significant determinant of the mean value of production in 1999 and the coefficient on the share of housing purchased with financing decreased by almost a quarter. Nevertheless, and more importantly, the coefficients on market activity and the share of new houses that are loan financed remain significant and are much larger in the year 2004 models of firm size and value. When builder size is measured by average value of construction per firm, housing market activity has an elasticity of 0.9!

The finding regarding the relationship between market size/activity and concentration is intriguing considering the disagreement between findings from previous studies of the homebuilding industry in Canada and the United States. As Buzzelli (2004) points out, Carroll (1988) found that in Canada, larger, more active housing markets have lower levels of market concentration of residential construction firms. In contrast, the study by Somerville (1999) of the industrial structure of housing supply in the United States found the opposite, although results were not statistically significant. Thus, in this regard Mexico resembles Canada.

3.5.1 Employment Formality in the Construction Industry

As discussed previously, requirements for preferential access to government mortgage loans for newly built housing developments are likely to increase participation in the Mexican Construction Industry Association, and by extension, formal employment in the

residential construction industry. Thus, factors associated with larger building firms are likely to also determine the share of residential construction employment that is formal. In order to test this hypothesis, the share of construction employment that is formal is regressed on the same set of independent variables used previously. It is possible to construct a good proxy for employment formality using the general census of population and housing, though unfortunately, the industry of employment is not detailed to the 4-digit NAICS level (residential construction) used previously. Nevertheless, analysis of formal employment in the construction industry overall, at the 3-digit NAICS level (construction excluding infrastructure installation and specialized contractors), yields significant and telling results.

The proxy for formality combines a person's health insurance status and occupation, making the assumption that unless they have access to health insurance, day laborers and other low-skilled occupations are informally employed (Suárez-Lastra 2007). Access to health insurance is an important indicator in Mexico because all salaried employees are legally required to have health insurance from the Mexican Institute of Social Security, unless an alternative provider is used by the employer (Diario Oficial de la Federación 2006). Alternative insurance providers are also reported in the census. Although it is possible for informal and unsalaried employees to purchase insurance from the IMSS independently, it is uncommon.

Table 3.6 OLS Regression Results: Determinants of Formal Employment in Construction, 1999/2000

Variables	% of Construction Employment Formal
ln(MSA size)	0.000
	[-0.019]
ln(hectares of developable land)	-0.011
	[-0.010]
ln(Median HH income, 2000)	0.181
	[-0.028]***
ln(New houses, 95-99)	0.000
	[-0.021]
% of new hsg. financed, 95-99	0.374
	[-0.073]***
Constant	-1.189
	[-0.232]***
Observations	112
R-squared	0.57
Adj. R-squared	0.55
F	28.43

Notes: White robust standard errors are in brackets. ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels.

In the year 2000, the share of construction employment that is formal in an MSA ranged from 6 to 60 percent, and as reported in Table 3.3, was roughly 30 percent on average. Table 3.6 reports the results of a regression of this percentage on MSA size, land supply, median household income, houses built between 1995 and 1999, and the share of these houses that were purchased with a mortgage. The model is significant and has a high explained variance, 55 percent. The median household income of a metropolitan area is strongly associated with the share of construction employment that is formal, with an elasticity of 0.2. Although the coefficient on market activity is not significant, that of the share of new housing that was purchased with financing is. For every 10 percent increase

in the new houses that were purchased with mortgages, there was a 3.7 percent increase in the share of formality in construction, a large effect, considering that this measures all construction employment, not only residential construction.

3.6 House Price Impacts of Lending, Firm Size, and Market Concentration

Unfortunately, there are almost no reliable data sources for real estate or housing prices in Mexico. Nevertheless, using data on the sale price of new housing built by the largest developer in the country, it is possible to extend tests of the impacts of government supported housing finance programs. Does increased lending at the metropolitan level reduce prices by creating a more competitive environment? Does market concentration lead to higher prices? Although the data are limited, the results are intriguing and suggest the need for further research.

Table 3.7 reports summary statistics describing new houses for sale from Casas Geo, one of the largest housing developers in Mexico. The data were taken from the homebuilders' website, which lists information by development, using a web scraping program (Casas Geo 2008). They describe 110 different housing models in 41 developments in 19 metropolitan areas in 14 states of the Mexican Republic. Fortunately, there is wide variation in the cities represented, from small cities such as Cadereyta Jimenez in Nuevo León, which had a population of roughly 70,000 in the year 2000, to the large metropolitan areas of Mexico City, Monterrey and Guadalajara.

Table 3.7 Summary Statistics of Selected Variables

Variable	Mean	Std. Dev.
House price (000s of 2008 pesos)	461.1	250.2
Lot size (square meters)	78.3	31.1
House size (square meters)	69.9	30.8
% with 2 floors	60.9	49.0

Source: Casas Geo (2008).

Three OLS regressions test the impact of market concentration and two measures of firm size by regressing the log of price on these variables on a variety of house and city characteristics. Table 3.8 reports the results of these regressions. House size is, of course, the most important determinant of price, and constitutes the majority of the explained variation. Nevertheless, other control variables such as the log of city size, median household income and market activity are also significant determinants. Larger and wealthier cities tend to have higher prices, while cities with more house construction activity tend to have lower prices.

In two of the three models, the share of new housing financed had a significant negative impact on house price, indicating that more lending seems to lead to increased competition in the formal homebuilding industry and thus, lower prices. This result is supported by the coefficient on the concentration ratio, CR4, which is positive and large, with an elasticity of 0.6. Markets in which there is more concentration in the largest residential construction firms have higher prices. The mean size of builder firms, on the

other hand, when measured by employees or the value of production, does not significantly influence housing prices.

Table 3.8 OLS Regression Results: Determinants of Casas Geo House Prices

Variables	ln(Price of housing unit)†	ln(Price of housing unit)†	ln(Price of housing unit)†
ln(Population, 2005)	0.366	0.425	0.358
	[-0.099]***	[-0.100]***	[-0.099]***
ln(Median HH income, 2000)	0.349	0.386	0.356
	[-0.151]**	[-0.160]**	[-0.166]*
ln(Lot size)	0.123	0.087	0.029
	[-0.089]	[-0.080]	[-0.089]
ln(House size)	1.058	1.097	1.128
	[-0.064]***	[-0.065]***	[-0.071]***
Two floors (0,1)	-0.119	-0.131	-0.165
	[-0.121]	[-0.118]	[-0.124]
ln(Hsg. growth, 2000-2005)	-0.302	-0.419	-0.389
	[-0.098]***	[-0.100]***	[-0.117]***
% new hsg. financed, 2000-2005	-0.310	-0.230	-0.494
	[-0.135]**	[-0.201]	[-0.244]*
CR4	0.605		
	[-0.177]***		
ln(mean firm size)		-0.020	
		[-0.093]	
ln(mean value)			0.133
			[-0.078]
Constant	3.148	3.598	3.542
	[-1.583]*	[-1.661]**	-1.607]**
Observations	96	96	96
R-squared	0.86	0.85	0.86
Adjusted R-squared	0.85	0.84	0.84
F	74.17	91.26	93.00

Note: Robust standard errors, clustered by metropolitan area, are in brackets. ***, ** and * indicate significance at the 0.01, 0.05 and 0.10 levels. † In 2008 pesos.

3.7 Conclusion

This paper provides evidence that the expansion of the housing finance system in Mexico in the last decade is one of the central drivers in the growth of large homebuilding firms and increased formal employment in construction. At the metropolitan level, the share of new housing purchased with mortgage financing significantly influenced the size of homebuilding firms in 1999 and 2004, measured by both the average number of employees and value of construction. The share of new housing purchased with mortgage financing also negatively influenced levels of market concentration and housing prices. Thus, it seems that markets where a larger share of new houses was purchased with mortgages had larger firms, but were more competitive.

The present analysis is important from the perspective of economic efficiency for two reasons. It seems that the preferential access to financing for a group of homebuilders has led to large-scale operations but not created a barrier to entry for new homebuilding firms, yet this analysis is quite broad and the subject merits further policy research given the strong connection between large builders and government lenders. Secondly, if it is the case that the government-supported housing finance system leads to large housing developments, potential negative urban efficiency impacts should be considered. Land assembly requirements for large developments mean that they will be in the urban periphery, leading to increased transportation and congestion costs, and single-use residential development means residents must travel farther for shopping and other

activities. However, the potential negative impacts of large-scale housing development must be weighed against their benefits in terms of providing low-cost housing options.

Although it seems that the transformation in the homebuilding industry has led to increased levels of formal employment in the construction industry, the present evidence is not detailed or definitive in this regard. Research remains to be done on whether large, national homebuilding companies are actually changing traditional construction employment practices and how policy might encourage further formalization of employment. Firms that receive preferential treatment from government agencies in financing the purchase of their product should not be permitted to employ large numbers of informal workers, neither from a tax nor labor standards perspective.

Chapter 4
Spatial Patterns of Residential Segregation

4.1 Introduction

The segregation of urban areas in Latin America is a recognized and much discussed phenomenon, but has not been well documented with quantitative analysis. The dearth of quantitative study reflects both the trend toward structuralism in the social sciences of the region and the difficulty, until recently, of gaining access to necessary spatial and census data. The study of segregation in Latin American cities is important, as the region has some of the highest levels of income inequality in the world, pronounced social divisions by race and class, and a majority urban population.

Although discrimination based on skin color pervades many countries in Latin America, the concept of segregation in the region usually refers to segregation based on socioeconomic status. Policymakers are generally concerned with informal neighborhoods and pockets of peripheral poverty, while academics often focus on the isolation of the wealthy behind walls. This focus on socioeconomic segregation is logical, given that processes of segregation in Latin America are quite different from the racial steering or housing discrimination found in the United States, for example, or the mandated racial separation of South Africa during Apartheid. In Latin America, the importance of urban development in determining residential location patterns cannot be understated. Socioeconomic segregation is not strictly a reflection of different groups' preferences for a certain combination of housing stock and transportation costs; it also

reflects housing market imperfections and the prevalence of informal housing solutions. Thus the segregation of people without access to the formal system is also an important component of socioeconomic segregation in the region.

The present study, which uses the dimensions of segregation outlined by Massey and Denton (1988) to describe the levels and patterns of segregation in Mexican cities, is the first national quantitative analysis of segregation in the urban system of a Latin American country. Mexico makes an ideal case for several reasons. It has the highest GDP per capita in the region and the highest level of income inequality (Organization for Economic Co-operation and Development 2008). In spite of nationalist politics promoting the concept of *mestisaje,* or racial mixing, discrimination based on skin color remains clearly evident in employment and media representation. Urban slums and illegal housing developments are also a characteristic problem of the country and the most frequently referenced example of the segregation of urban space in Latin America.

Although this study uses Massey and Denton's dimensions of segregation as a framework, it is not methodological and does not replicate the factor analysis of measures in their original paper or in later work by Massey, White, and Phua (1996). Rather, one measure of each dimension is used as a convenient framework for describing segregation, as well as to facilitate comparison. Thus, in addition to measures of evenness, exposure, and clustering, this research measures centralization and concentration of different socioeconomic and indigenous groups. The last two dimensions of segregation allow for

the quantification of such patterns as the settlement of low-income groups in urban peripheries.

Findings reported here confirm and quantify the three patterns of residential segregation frequently found in Latin American cities: the clustering of high-income households in a central zone, the settlement of low-income households at the urban fringe, and the income heterogeneity of high-income neighborhoods compared with low-income ones. The analysis also yields an unexpected result. In spite of the discrimination, extreme inequality, and social divisions that characterize Mexico, the segregation of indigenous people and low-income households is not high and, in fact, is much lower than that found in the United States. Furthermore, high-income households tend to be more isolated and concentrated than low-income households due to the nature of initial urban settlement processes.

4.2 Literature Review

Latin America has a history of systematic racial segregation in urban areas dating back to the colonial period. A set of Spanish laws, which began as the *Laws of Burgos* in 1512 and was later expanded to become the *Compilation of the Laws of the Kingdom of the Indies* in 1680, set strict guidelines about almost every aspect of city planning and urban life. These laws also regulated interactions between Spanish colonists and indigenous people, forbidding not only the residence of indigenous groups in areas inhabited by the Spanish, but also the "residence of mulattoes, *mestizos* and Negros in company of

Indians" (Mörner and Gibson 1962:561). Nevertheless, and in spite of continued discrimination based on skin color (Flórez, Medina, and Urrea 2001; Psacharopoulos and Patrinos 1994), contemporary discussion of urban segregation in the region generally refers to socioeconomic segregation, with the notable exception of Brazil (Telles 1992). This lack of focus on racial segregation stems principally from the politics of miscegenation, or racial mixing, which tends to dominate the discourse on racial identity in the region and prevent open debate about racism (Telles 2007).

The distribution of socioeconomic groups within urban areas of Latin America and the United States were similar before the 19th century, with high-income residents living in the central city and low-income groups settling on the outskirts. However, the spatial structure of cities in the two regions diverged during the course of the 19th and 20th centuries. Early industrialization and capital investment in the city centers of the United States combined with strict land-use regulation in suburban areas segregated the poor in central cities. In Latin America, by contrast, rapid urbanization during the latter half of the 20th century was characterized by rural migrants building informal settlements at the periphery of cities, and later, by the consolidation of these settlements and their incorporation into the city (Mangin 1967; Ward 2001).

The urban spatial structure in most of Latin America has three generally recognized characteristics: 1) high-income groups are clustered in one zone of the city, generally with an apex in the historical center and moving outward in one direction; 2) the poor often occupy low density, peripheral and poorly-serviced areas; and 3) poor areas are

more homogenous in terms of income than rich areas (Sabitini 2003). Scholars continue to debate the impact of industrialization and inequality on socioeconomic segregation, but the importance of historic urban development trends in segregation outcomes is not disputed (Lungo and Baires 2001).

Academic attention to residential segregation in Latin American cities has grown; in part because of expanded access to higher quality georeferenced census data but also due to changes in the urban development process itself. Increased investment in gated suburban communities and enclosed shopping centers in urban peripheries has engendered a discussion of Latin American suburbanization (Borsdorf 2003). In contrast to the United States, however, this suburban development is generally located in only segment of the periphery, with the majority of peri-urban areas still dominated by low-income groups or manufacturing facilities. The academic debate over these new suburbanization patterns is reminiscent of discussion over mid-century urban growth trends in the United States, which linked suburban development to increased crime and social strife in central cities and the decentralization of manufacturing (Caldeira 2000; Telles 1995).

Some scholars have argued that new urban growth patterns are exacerbating social disparity and changing the scale of segregation in Latin American cities, from large-scale clustering patterns to smaller, unevenly distributed pockets of segregation. One study found that new gated housing developments for high-income residents in Buenos Aires have been built mostly in poor municipalities (Libertun 2006). Sabatini, Caceres, and Cerda (2001) studied segregation in the three largest cities in Chile and found that the

scale of segregation is changing there in a similar way. High-income and low-income groups are living closer together in urban peripheries, though separated by walls, and middle- and low-income groups are becoming increasingly isolated in older, more centrally located neighborhoods.

Despite scholars' long-standing attention to segregation in Latin America, only recently have they employed quantitative methods in their research. Three papers from countries outside of Mexico stand out in this area. The first, by Rodríguez and Arriagada (2004) (based on a report published by the same authors under different names, Luco and Vignoli (2003)), argues that comparative empirical analysis of socioeconomic residential segregation among Latin American countries and its determinants is important in order to inform urban policy debate. They present calculations of segregation indexes for Santiago, Chile; Mexico City; and Lima, Peru.

The second paper, a study of urban segregation in Brazil, is the only study that calculated and compared quantitative measures of segregation for a large number of cities in Latin America (Telles 1995). Telles compared the entropy of 40 cities in Brazil in 1980. That paper and a previous one (Telles 1992) measuring segregation of the African population in Brazil yielded the same surprising result found in the study reported here - Brazilian cities are less segregated than United States cities. Though it is the most robust analysis of segregation in Latin America to date, the study does not examine the large-scale or clustering dimension of segregation, nor does it assess spatial patterns using measures of centralization or concentration.

The third paper, by Peters and Skop (2007), does focus on spatial patterns, providing an in-depth, quantitative study of segregation in one city, Lima, Peru, using multiple spatial segregation measures for several different variables ─ level of education, type of employment, the tenancy of dwelling units, and socioeconomic status. Peters and Skop found that Lima is more segregated by socioeconomic status and tenancy than it is by education or employment. Results also suggest the zonal nature of segregation in Lima, or the dominance of large-scale over small-scale trends, although this hypothesis was not tested explicitly. They also show that wealthy municipalities of the Lima metropolitan area tend to be less segregated than poor ones.

In Mexico, a review by Schteingart (2001) of the literature on the social division of urban space explains how, apart from research based in methodologies of the Chicago School of sociology (Park, Burgess, and McKenzie 1925), urban research in Mexico has traditionally emphasized theories of marginality and critiques of said theories, rather than ideas of social exclusion. Schteingart also points out that quantitative analysis of segregation in Mexico was limited until the 1990s because georeferenced census data were not available. A number of quantitative research papers on social exclusion in Mexico have been published since 1990 (Alegría 1994; Ariza and Solis 2009; Duhau 2003; Garza 1999; Gonzalez Arrellano and Villeneuve 2006; Hernández Gómez 2001; Rubalcava and Schteingart 2000a; Rubalcava and Schteingart 2000b). With one exception, however, none used measures of segregation that are standard in the US literature, relying instead primarily on such aspatial techniques as factor analysis to group

large numbers of socioeconomic and demographic variables into a description of urban space. Furthermore, these papers are limited geographically, studying only the five largest cities in Mexico – Mexico City, Guadalajara, Monterrey, Puebla, and Tijuana.

The paper most relevant to the present study used Massey and Denton's (1988) measures of the five dimensions of segregation to examine four aspects of socioeconomic status (income, occupation, migration status, and level of education) for the three largest cities in Mexico - Mexico City, Guadalajara, and Monterrey (Ariza and Solis 2009). The authors provide some evidence of the previously assumed spatial patterns of segregation in Mexico, although they are not explicitly tested. The paper does not present patterns visually, nor does it examine the segregation of low-income households, making it difficult to discuss location patterns of such households. Furthermore, the measure of income used restricts the analysis to a comparison of the highest income households (5 percent of the population in some cases) to the all the rest, yielding an incomplete picture of segregation in these cities.[13] As will be demonstrated here, higher-income groups tend to be much more segregated – on all dimensions – than low-income households.

4.3 Measuring Segregation in Mexican Cities

Not only do quantitative measures assist in analyzing patterns and levels of segregation, they also draw attention to the role residential location plays in how race and class in determine life outcomes and persistent poverty in Mexico. In contrast to the United

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[13] Ariza and Solis isolated households at a significantly higher income bracket than in the present paper, which is why their values differ from those reportedhere.

States, where the academic debate over race and class (William Julius Wilson 1978; Massey and Denton 1993) has persisted for decades, in Mexico it is only beginning to resurface. For most of the 20th century, understanding of racial discrimination was obfuscated by the profound and longstanding presence of nationalist politics that emphasizes the values of racial and cultural hybridism in the country. After the Mexican Revolution, books such as *Forjando Patria* by Mexican anthropologist Manuel Gamio outlined the construction of a culturally mixed nation built on the concept of the *mestizo*, or mixed person. This notion was used by the government to unite the country and was famously extended by the Secretary of Education José Vasconcelos in his 1925 book, *La Raza Cósmica*, which argued that the *mestizo* race was in fact a superior or cosmic race (Knight 1990).

The spatial component of the connection between race, class, and poverty in Mexico also provides a contrast to that of the United States. The mismatch between the location of low-income housing and jobs often discussed in the United States (for a review, see Ihlanfeldt and Sjoquist 1998) is inverted in Mexico and most of Latin America. Housing for low-income groups is found mostly in the periphery of cities, but in many places formal jobs have not yet suburbanized (Suárez-Lastra and Delgado-Campos 2007). As argued by Suárez-Lastra (2007), however, this spatial mismatch is attenuated by the prevalence of informal employment, which is not centralized, in low-income neighborhoods. The spatial relationship between formal employment and residential location is especially strong in Mexico because the large publicly run mortgage lending system lends exclusively to formally employed people.

Thus, the present study measures the segregation of informally employed workers, indigenous people, and high- and low-income households across the five dimensions of segregation proposed by Massey and Denton (1988), which Johnston, Poulsen, and Forrest (2007) have conveniently consolidated as two super dimensions – *location* (concentration and centralization) and *separation* (clustering, evenness, and exposure).

The data used in the present study come from the Mexican general census of population and housing for 2000 (Instituto Nacional de Estadísticas, Geografía e Informática 2000a) and the digital urban cartography of the same year for geographic calculations (Instituto Nacional de Estadísticas, Geografía e Informática 2000b). Data tabulations are created for *basic geo-statistical areas* (AGEBs), which are the equivalent of census tracts in the United States. AGEBs can be larger than census tracts in the United States – more than 10,000 people in some cases – but are mostly similar in size, with 2,500 people in each on average.

The study employs proxy variables for informal employment and ethnicity. The proxy for informal employment is based on the existing understanding of informal work (Castells and Portes 1989; AlSayyad 2004; Biles 2007) and made up of three variables in the census: health insurance status, occupation and industry of employment. Health insurance status indicates formal employment, as all salaried employees and their families are guaranteed health insurance from the Mexican Institute for Social Security by law (Diario Oficial de la Federación 2006a and 2006b). Occupation and industry are also good

indicators; professionals are considered to be formally employed, as are those who work in healthcare, education, finance, telecommunications, or government-owned industries. This proxy for informal employment has been used before (Suárez-Lastra 2007). The proxy for ethnicity is whether a person speaks an indigenous language. Although this measure likely excludes a large number of people who suffer from discrimination based on skin color, it is the only measure available (Telles 2007).

Income data used here are at the household level. Household income in Mexico is often measured in multiples of minimum wages earned and is frequently reported categorically. In 2000, one minimum wage was defined as 32.7 to 37.9 Mexican pesos, or 4.13 to 4.79 U.S. dollars, per day. The minimum wage varies slightly by region. This paper used census tabulation data (Instituto Nacional de Estadísticas, Geografía e Informática 2000c), in which high-income households earned more than 5 minimum wages and low-income households earned 1 minimum wage or less.

The study includes the 128 Metropolitan Statistical Areas (MSAs) in Mexico. Although in Mexico the term "metropolitan area" generally refers to cities that encompass more than one municipality, for the purposes of this study, MSAs are defined as they are in the United States, municipalities (counties) with an urban core of 50,000 or more people. These urban areas are referred to here either as MSAs or cities. It is worth noting that the study covers only the central urban core and the tracts within 10 miles of this urban core, not the smaller towns that often are present in some municipalities.

Table 4.1 presents summary data for the variables by which segregation will be measured. These averages provide an initial idea of how drastically residential segregation in Mexico differs from that in the United States, where it is traditionally conceived of as the isolation of a minority population. In Mexico, low-income households outnumber high-income households in almost every city and by 2 to 1 or more on average in smaller cities. This situation is inverted in the United States; a recent study found that affluent households outnumbered poor households by 2 to 1 (Fischer 2003). Additionally, the share of indigenous people, at least as captured by the census, is much lower on average than the share of African-Americans or Latinos in the United States, further complicating comparison.

Table 4.1 Informally Employed, Indigenous, High-income, and Low-income Residents in 128 Mexican Cities, by City Size

Variable, Percent	Large Cities[a] (N=9)		Medium-Sized Cities[b] (N=52)		Small Cities[c] (N=67)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Informal	41.4	9.5	42.1	9.4	51.1	15.1
Indigenous	1.6	1.7	3.6	4.9	4.8	14.0
High-Income	17.0	4.4	12.3	4.0	9.5	4.4
Low-Income	23.5	5.8	31.2	8.5	35.7	11.2

Source: INEGI (2000a).
[a]Large cities have more than one million residents. [b]Medium-sized cities have 200,000 to one million residents. [c]Small cities have fewer than 200,000 residents.

4.4 Dimensions of Segregation in Mexico

In this section, before reporting measures of the dimensions of segregation, a visual representation of a city that exemplifies spatial patterns of segregation in Mexico is presented. The city of Mérida, Yucatán, is used here and throughout the following anaylsis as a reference. It is one of the country's rapidly growing medium-sized metropolitan areas, consisting of five municipalities with a total popualtion of almost 900,000 in 2005. It has a slightly higher than average rate of poverty (35 percent of households make less than one minimum wage as compared to an average of 32 percent in all Mexican cities), a roughly average share of high-income households, and a slightly lower than average share of people in informal employment (36 percent of workers are informally employed as compared to an average of 47 percent in all cities). Mérida was chosen as the reference city for two reasons. First, it has a significant indigenous population; roughly 30 percent of residents speak an indigenous language. More importantly, however, it is a highly segregated city, and the observed patterns of segregation in Mérida clearly demonstrate trends across cities in Mexico.[14]

Figures 4.1 – 4.5 show the spatial distribution of informal employment, households with at least one member who speaks an indigenous language, income diversity, and high- and low-income households, as well as those census tracts that have statistically significant spatial autocorrelation in those same variables according to the local Moran's I test in the city of Mérida, Yucatán. The local Moran's I, developed by Luc Anselin

[14] Based on visual inspection of choropleths for all cities and segregation measures to follow in this paper. Images of clustering and the definitions of metropolitan statistical areas and segregation index values are available in the online supplement to this paper.

(1995), provides a nuanced perspective of clustering by testing whether the spatial autocorrelation between a tract and its neighborhood is statistically significant.[15] Tracts that form clusters can then be identified on a map and provide a visual representation of segregation patterns.

The city of Mérida, as shown in the figures, exemplifies the three most notable patterns of segregation in Latin America. First, low-income households and informal workers tend to be concentrated in the periphery of the city, while high-income households and formally employed workers are more centrally located. Indigenous people, who are often poorly paid and informally employed, also tend to live in the urban periphery. The second pattern is the tendency of informally employed workers and low-income households to form small and fragmented clusters and of formally employed workers and high-income households to be clustered in one large group.

[15] Mathematical definitions for this and all segregation measures can be found in Appendix A.
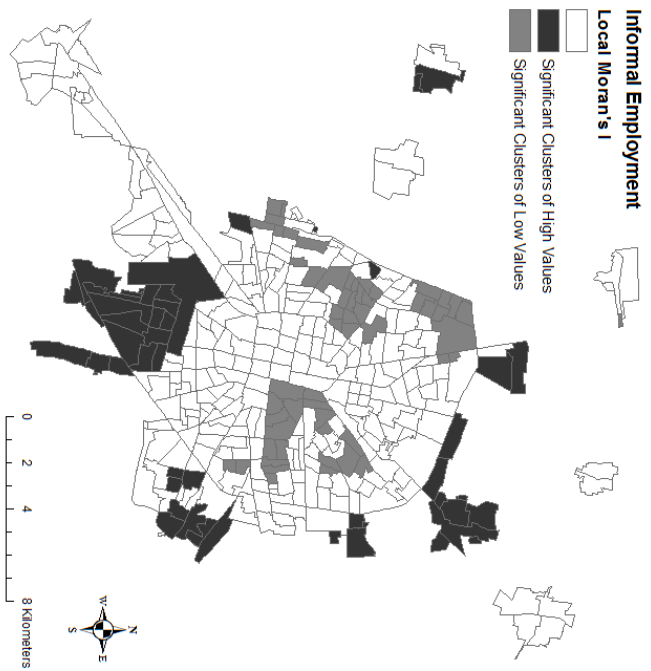
Source: Author, from INEGI (2000a and 2000b).

Figure 4.1 Distribution and significant clusters of informally employed workers in Mérida, Yucatán, 2000

91
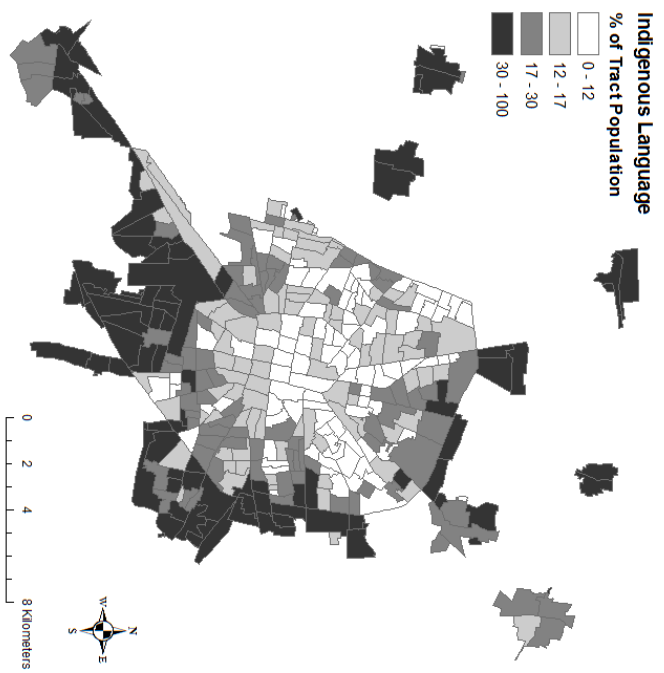
Source: Author, from INEGI (2000a and 2000b).

Figure 4.2 Distribution and significant clusters of people that speak an indigenous language in Mérida, Yucatán, 2000
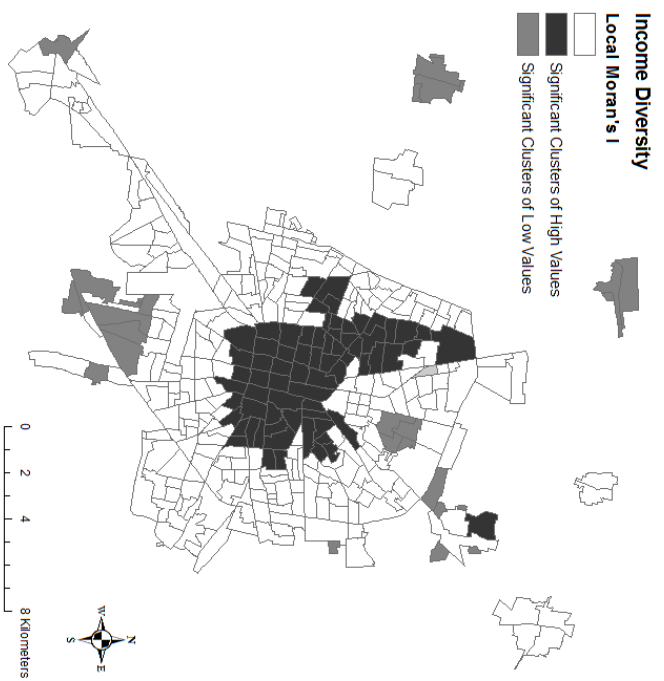
Source: Author, from INEGI (2000a and 2000b).

Figure 4.3 Distribution and significant clusters of census tracts by level of income diversity (entropy) in Mérida, Yucatán, 2000
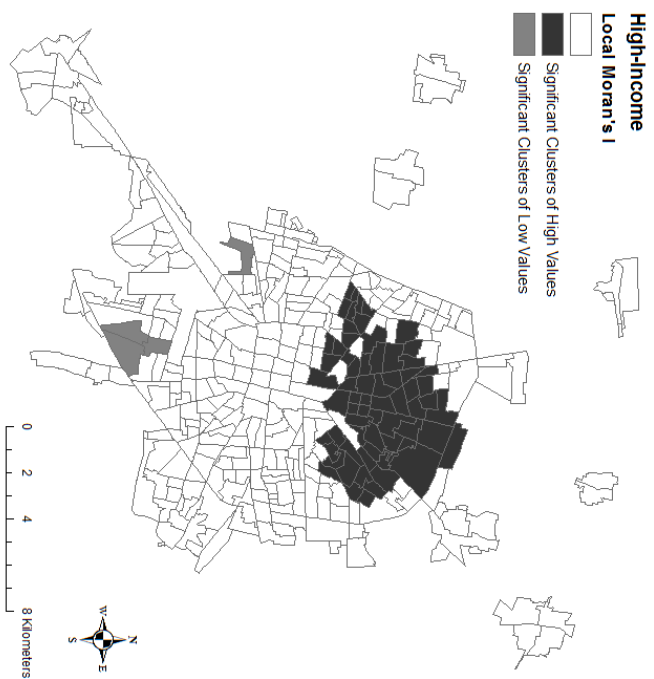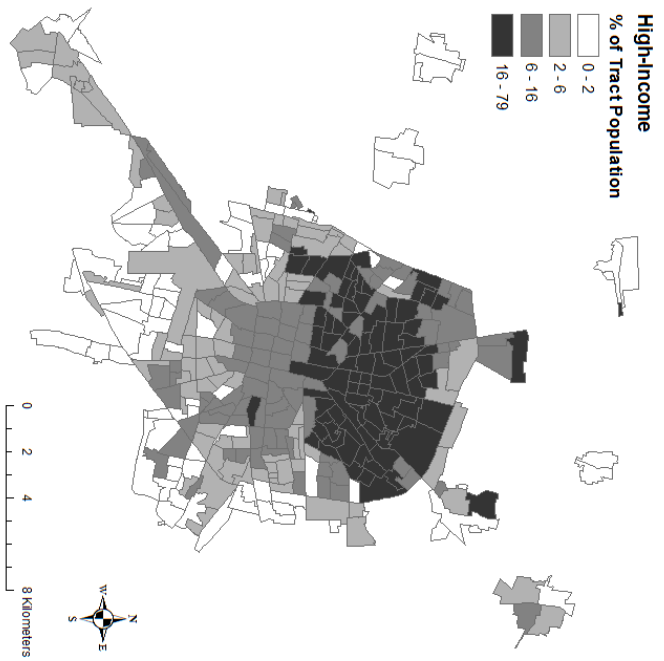
Figure 4.4 Distribution and significant clusters of high-income households in Mérida, Yucatán, 2000

Source: Author, from INEGI (2000a and 2000b).
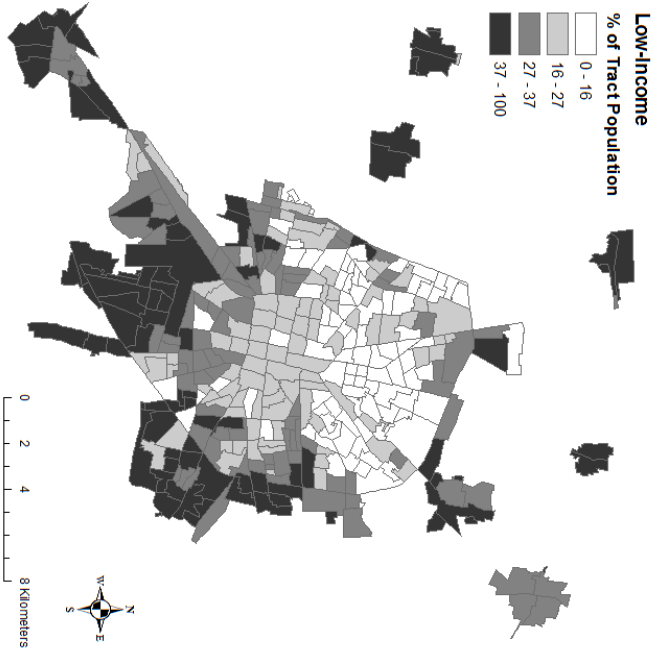
Source: Author, from INEGI (2000a and 2000b).

Figure 4.5 Distribution and significant clusters of low-income households in Mérida, Yucatán, 2000

Figure 4.3 also shows the greater income heterogeneity of high-income areas as compared with low-income ones. Using the local Moran's I, it is possible to statistically test this pattern by simply comparing the entropy of income for the two parts of the cities in the sample. The entropy of income indicates the diversity of its constituent parts; more heterogeneous areas will have a higher entropy. The average entropy of income in high-income neighborhoods in the 101 cities that have significant clusters of both high- and low-income groups is 1.55, whereas that of low-income areas is 1.22. The entropy of the high-income neighborhoods exceeds that of low-income by 0.33, roughly 20 percent of their combined entropies and a difference that is statistically significant at the 0.01 level according to a two sample t-test with unequal variances (t = 8.89).

4.4.1 Clustering

Clustering is the tendency of subunits of a city with high proportions of a group to adjoin each other. As shown mathematically in Appendix A, the local Moran's I used above can be aggregated to generate an index of clustering, known as the global Moran's I (Moran 1950). Global Moran's I values are presented in Table 4.2. Values are reported for all cities and for those cities that have a statistically significant level of clustering. Informally employed people are more clustered than either income group or indigenous people on average. Furthermore, indigenous people tend to experience relatively low levels of clustering, in spite of experiencing much higher levels of segregation on measures of evenness. As hypothesized, high-income households are more clustered than

low-income households, as they tend to reside in one zone of the city whereas low-income households are more dispersed.

An average value of clustering measured with the Moran's I test is not available for the metropolitan areas of other countries, though Martin's analysis of several cities (1991) suggests that clustering by income is slightly higher in the United States (around 0.40 in the cities analyzed) and clustering by race can be much higher (as high as 0.80 in Oklahoma City). There is limited evidence that other Latin American cities also have higher values of clustering than in Mexico, according to the global Moran's I. Lima, Peru, for example, had a Moran's I of 0.70 for socioeconomic status (Peters and Skop 2007), higher than the vast majority of cities in Mexico.

Referring back to the choropleths shown in Figures 4.1 – 4.5 can assist in visualizing the relationship between the local and the global Moran's I. Mérida has a global Moran's I of 0.32 for informal employment, which is below average. However, the city stands out in segregation by ethnicity and income. The population that speaks an indigenous language is in the top 10 percent of cities by their global Moran's I scores, meaning that they tend to be much more clustered than in other cities. Merida also has the second most clustered high-income households of any city in the entire country and is in the top quarter in clustering of low-income households, with global Moran's I values of 0.67 and 0.42 for high and low income, respectively.

4.4.2 Evenness

The most commonly measured dimension of segregation is evenness, the difference in distribution of two groups over subunits of a city. The entropy index, originally developed by Theil (1972), has been shown to be the most appropriate index of evenness (Harsman and Quigley 1992). It indicates the extent to which the composition of tracts deviates from the citywide composition of a given variable and can be expressed as the percent difference between the existing distribution of given groups and a completely even distribution. The index of dissimilarity, the percent of a given group that would need to move in order to achieve an even distribution, is also reported here for comparison, given its prevalence in the literature on segregation.

Values for dissimilarity and entropy are presented in Table 4.2. Although some cities in Mexico have high levels of ethnic segregation, average values are lower than those found in the United States. The average index of dissimilarity of ethnicity in all cities is 0.34, and for cities with indigenous populations of more than 3 percent is 0.42. This is much lower than the average index of dissimilarity for African-Americans or Latinos in the United States, which were 0.64 and 0.51 in 2000 (Iceland, Weinberg, and Steinmetz 2002).

Table 4.2 Four Separation Indexes of Segregation in 128 Cities, by City Size Category

Variable	Large Cities[a] (N=9)		Medium Cities[b] (N=52)		Small Cities[c] (N=67)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Moran's I						
I – Informal	0.53	0.23	0.45	0.18	0.41	0.24
I – Informal†	0.53	0.23	0.42	0.19	0.29	0.28
I – Indigenous	0.23	0.13	0.28	0.18	0.28	0.37
I – Indigenous†	0.19	0.13	0.14	0.19	0.08	0.22
I – High-income	0.47	0.08	0.37	0.12	0.31	0.19
I – High-income†	0.47	0.08	0.36	0.13	0.24	0.19
I – Low-income	0.32	0.19	0.34	0.20	0.39	0.18
I – Low-income†	0.31	0.17	0.30	0.21	0.20	0.22
Dissimilarity						
D – Informal	0.19	0.05	0.20	0.04	0.19	0.05
D – Indigenous	0.41	0.14	0.34	0.14	0.32	0.13
D – High-income	0.35	0.05	0.34	0.05	0.29	0.07
D – Low-income	0.18	0.03	0.17	0.03	0.16	0.04

[a] Large cities have more than one million residents. [b] Medium-sized cities have between 200,000 and one million residents. [c] Small cities have fewer than 200,000 residents.
† The second Moran's I value reported is for the cities that have a statistically significant (p<0.05) value. These have an N of 103 for informal, 47 for indigenous, 100 for high-income, and 82 for low-income.
†† Income is a multi-group entropy index calculated using 5 income categories.

Table 4.2 Four Separation Indexes of Segregation in 128 Cities, by City Size Category (continued)

Variable	Large Cities[a] (N=9)		Medium Cities[b] (N=52)		Small Cities[c] (N=67)	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Entropy						
H – Informal	0.05	0.02	0.05	0.02	0.05	0.02
H – Indigenous	0.15	0.14	0.11	0.14	0.09	0.11
H – Income††	0.06	0.02	0.05	0.01	0.04	0.01
H – High-income	0.13	0.03	0.11	0.03	0.07	0.03
H – Low-income	0.04	0.01	0.04	0.01	0.03	0.02
Exposure						
xP*y – Informal	0.55	0.10	0.54	0.10	0.46	0.15
xP*y – Indigenous	0.89	0.18	0.88	0.23	0.90	0.21
xP*y – High-income	0.69	0.13	0.79	0.06	0.85	0.12
xP*y – Low-income	0.74	0.06	0.66	0.09	0.61	0.14

[a]Large cities have more than one million residents. [b]Medium-sized cities have between 200,000 and one million residents. [c]Small cities have fewer than 200,000 residents.

† The second Moran's I value reported is for the cities that have a statistically significant (p<0.05) value. These have an N of 103 for informal, 47 for indigenous, 100 for high-income, and 82 for low-income.

†† Income is a multi-group entropy index calculated using 5 income categories.

The limited evidence available suggests that cities in Mexico are less segregated by socioeconomic status than cities in other Latin American countries. Measures of socioeconomic dissimilarity in most Mexican cities are less than those of Santiago de Chile, which vary between 0.30 and 0.47 (Rodriguez and Arriagada 2004), and of Lima, Peru, which had a D of 0.52 for an aggregate index of socioeconomic segregation (Peters and Skop 2007). Entropy measures of income segregation are also lower than those for cities in Brazil, which ranged from 0.08 to 0.15 (Telles 1995).

4.4.3 Exposure

Exposure, as originally posed by Massey and Denton, is the potential for interaction or contact between members of two population groups. It is included here for consistency, but it seems a poor measure for the concept. A true measure of interaction between two groups would be extremely difficult to calculate, as it would require such information as the mode of transportation used by different groups, where they work, where they shop, etc. People might live near one another, but if their houses are enclosed by walls and they travel exclusively by car, the exposure and isolation indexes commonly used completely fail to capture the experience of segregation. Nevertheless, these indexes are useful in that they provide a measure similar to evenness, but one that is not normalized by the total size of a population group in a city.

Table 4.2 reports exposure indexes for the 128 cities in Mexico. Indigenous people have the highest levels of exposure, as they tend to constitute a very small share of the

population. There is an interesting relationship between the exposure of high- and low-income households and city size. In larger cities, low-income households have higher levels of exposure, while in smaller cities the reverse is true. This is likely due to the smaller share of high-income households in small cities.

4.4.4 Centralization

In contrast to the tendency of low-income groups in the United States to occupy central areas of cities, low-income groups in Latin America tend to live in the periphery. An absolute centralization index (ACI) is calculated to measure the degree to which different groups live near the center of the city. ACI values range from -1 to 1, where higher values indicate a greater level of centralization. A value of 0 would mean that all members of a group are evenly distributed from the center to the periphery and a value of 1 that all members of that group live in the central polygon.

The ACI values for the 128 cities in Mexico are reported in Table 4.3. The mean ACI of informally employed people, 0.21, and low-income groups, 0.20, compared with that of the population overall, 0.25, indicates that informally employed and low-income populations tend to live in the peripheral areas of cities, confirming commonly held notions. In contrast, high-income households, which have an ACI of 0.37, tend to live in much more central locations than do low-income and informally employed people as well as the population overall. People that speak indigenous languages are also more decentralized than the population and even low-income households on average.

In order to connect numbers to visual patterns, it should be noted that the city of Mérida, Yucatán, pictured in Figures 4.1 – 4.5, is more centralized than average, with a population ACI of 0.32, but the centralization patterns of low-income, high-income households, indigenous people and informal employees are representative of the average city. The informally employed population and low-income households are less centralized than the entire population, with an ACI of 0.27 and 0.30 respectively. People that speak an indigenous language, who have an ACI of 0.15, tend to live in peripheral areas. High-income households are much more centralized than the overall population with an ACI of 0.41. In Mexico, these patterns hold in the vast majority of cities; informally employed people and low-income households are less centralized than the population overall in 101 and 105 of 128 cities, respectively, and high-income households are more centralized than the overall population in 114 of 128.

4.4.5 Concentration

In order to measure the land area occupied by different income groups and formally/informally employed people in Mexican cities, the delta index, which can be considered a special case of the index of dissimilarity, is used. Problems with this concentration index have been documented (Egan, Douglas, and Weber 1998); however, these problems stem principally from the limitations of using data at the census tract level. Delta can be interpreted in a similar fashion to the index of dissimilarity, the percent of people from a group that would have to shift units in order to achieve uniform

density. The higher the delta, the less land area a group occupies. The absolute concentration of the overall population is also calculated in order to compare it to the concentration of certain groups.

Values of delta for the 128 cities in Mexico are presented in Table 4.3. On average, informally employed and low-income groups are slightly less concentrated than the overall population. High-income households and indigenous people are much more concentrated than the population overall. It is surprising that indigenous people have high delta values, given that on other indexes they tend to have values similar to those of low-income groups. This suggests that though they live in peripheral areas, they occupy less space than otherwise similar non-indigenous people. Informally employed people were found to be less concentrated than the overall population in 93 of 128 cities, and high-income households were found to be more concentrated than low-income households in 118. The fact that informal and low-income groups seem to occupy more land than their formal and high-income counterparts do does not mean they occupy larger living spaces; rather, it simply indicates that they inhabit areas with lower density on average. Frequently, these areas are of low density because they are on hillsides, where high-density development is not possible, or because they are recently settled areas that as yet have not urbanized completely.

Table 4.3 Two Location Indexes of Segregation in 128 Cities, by City Size Category

Variable	Large Cities[a] (N=9)		Medium Cities[b] (N=52)		Small Cities[c] (N=67)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Absolute Centralization						
ACI – Population	0.25	0.09	0.24	0.11	0.26	0.12
ACI – Informal	0.21	0.09	0.18	0.12	0.23	0.13
ACI – Indigenous	0.16	0.13	0.17	0.25	0.19	0.24
ACI – High-income	0.38	0.14	0.35	0.13	0.39	0.16
ACI – Low-income	0.22	0.11	0.19	0.13	0.21	0.12
Concentration						
DEL – Population	0.40	0.03	0.38	0.06	0.38	0.08
DEL – Informal	0.38	0.04	0.36	0.06	0.37	0.08
DEL – Indigenous	0.49	0.08	0.47	0.09	0.44	0.10
DEL – High-income	0.50	0.08	0.48	0.06	0.47	0.11
DEL – Low-income	0.39	0.05	0.37	0.06	0.36	0.09

[a]Large cities have more than one million residents. [b]Medium-sized cities have between 200,000 and one million residents. [c]Small cities have fewer than 200,000 residents.

4.5 Conclusion

The present study provides the first comprehensive analysis of residential segregation in the urban system of a Latin American country. The segregation of informally employed and indigenous people, as well as high- and low-income households is measured in the metropolitan areas of Mexico. Spatial patterns are described with measures of the traditional dimensions of segregation and the visual reference of an exemplary Mexican city. This paper documents three segregation trends that characterize cities in Latin America: the clustering of high-income groups in a central zone, the dispersal of low-income groups throughout large peripheral areas, and the relatively greater diversity of high-income areas as compared to those of low-income residents. The paper also shows that, unexpectedly, levels of segregation are not high in Mexico compared with those of the United States.

The relatively low levels of socioeconomic segregation found in spite of high levels of income inequality in Mexico may be explained by a combination of factors, including the land and housing markets, the structure of local government, and the nature of land-use regulation. The incremental housing construction process that dominated urban development in Mexico until recently, in which families build houses slowly over time, creates neighborhoods that tend to be more heterogeneous than those built as tract housing developments. It is difficult for homogenous suburban areas to develop given the lack of incorporated cities in Mexico and generally lax enforcement of existing land-use and construction regulations. Furthermore, the motivation of municipal governments

to enact and enforce land-use and other urban development regulations, and the increased property taxes that might result from this regulation, is not present because property taxes play a small role in municipal finance in Mexico (Dalsgaard 2000). Clearly the hypotheses proposed here are preliminary, and more theoretical and empirical work is needed on the relationship between the housing and land markets and segregation outcomes in Latin America, as well as the connection between informality, access to housing and employment, and other economic outcomes.

The present study suggests three directions for the emerging research agenda on segregation in Latin America. First, researchers in the region should begin to assess the policy and planning implications of residential segregation more directly, chiefly in regard to the relationship between land and housing markets and segregation outcomes. Second, researchers should strive to standardize segregation measures to facilitate comparison between countries. Finally, collaboration is necessary in order to expand access to geo-referenced census data, which could contribute to analysis of segregation trends in different countries of Latin America. The creation of a data depot of GIS and census data in the region would be especially useful.

Chapter 5
Housing Finance and Increasing Socioeconomic Segregation

5.1 Introduction

New suburbanization trends and the emergence of peri-urban gated communities in Latin America have led to increased academic attention to segregation in the region. Scholars argue that that new patterns of urban growth are changing the urban spatial structure of Latin American cities, especially in regard to patterns of socioeconomic segregation (Borsdorf 2003; Sabatini, Caceres, and Cerda 2001). They assert that new development of housing and services for high-income households in the urban periphery, a departure from the large-scale segregation patterns of poor peripheral areas and wealthy central cities, is fragmenting Latin American cities.

In Mexico, suburbanization trends and changing urban growth patterns are different from and perhaps more fundamental than in the rest of Latin America. Reform and expansion of the government-run housing finance system that began in the early 1990s has changed the way housing is produced and acquired in the country. More housing is now built on speculation by private-sector homebuilding firms and purchased with mortgages than by the incremental building process through which most households previously acquired housing. Suburban housing developments of single-family tract homes for middle-income and working class households have proliferated in Mexico. Thus, although there is a clear

trend toward the formal development of suburban residential areas, they are not exclusively high income.

In contrast to the shifts in urban development in other countries in Latin America, the large homogenous neighborhoods and increased residential mobility under the new housing finance system in Mexico is likely to exacerbate levels of socioeconomic segregation. Unlike the small gated communities being built in Brazil, Chile, or Argentina, new housing developments in Mexico often have hundreds or thousands of similar houses. The size and homogeneity of housing developments create neighborhoods that are more segregated than incrementally built places, where households tend to add on or improve their existing house when incomes increase, rather than move to a new unit.

In spite of the increasing attention to segregation in Latin America, there has been little quantitative analysis to test the assertions about the determinants of segregation and segregation trends. This paper calculates measures of segregation by income and the share of income segregation conditional on the distribution of housing stock in 1990 and 2000 and tests a series of hypotheses about factors that determine levels of and changes in segregation in Mexican cities. It incorporates insights from recent research on the relationship between urban land-use and segregation from the United States and research on industrialization and segregation in Latin America to categorize theoretical determinants of segregation into four groups: economic factors, urban growth factors, land-use factors, and housing factors. In order to test the central hypothesis regarding the

impact of changes in the housing finance system, a variable describing the prevalence of the new housing finance system in a city is included in the set of housing factors.

Findings show that land-use patterns and housing market characteristics are more important determinants of income segregation and the share of income segregation conditional on the quality of housing stock in 2000 than economic characteristics of the metropolitan area. In fact, median household income and income inequality are not significantly associated with income segregation, when controlling for city size. The share of housing purchased with financing is the only factor that has a similar impact on both segregation and conditional segregation, significant and positive in both cases. Determinants of *changes* in income segregation and the conditional income segregation during the 1990s, however, are similar. The share of new housing built with financing, is also a significant and important determinant of both, which suggests that, in fact, the new finance system is creating more segregated neighborhoods.

The paper has three sections. The first reviews literature on recent changes in urban development and segregation patterns in Latin America and Mexico, as well as theories on the determinants of segregation. In the second, data on trends in socioeconomic segregation in Mexican cities are presented. The third section analyzes the determinants of segregation levels, conditional segregation and changes in the two during the 1990s in a series of regression models.

5.2 Literature Review

Latin America is a predominantly urban region. Although the majority of the cities were established during colonial times, the urban transition itself occurred rapidly during the latter half of the 20th century. The share of the population living in cities grew from roughly 40 percent in 1950 to more than three quarters today (Lattes, Rodríguez, and Villa 2002). This period of urbanization was characterized by rural migrants building informal settlements at the periphery of cities, and later, by the consolidation of these settlements and their incorporation into the city (Mangin 1967; Ward 2001). This pattern of growth led to a Latin American urban spatial structure characterized by high-income groups clustering in one zone of the city, generally with an apex in the historical center, and the poor occupying low-density, peripheral, and poorly serviced areas (Sabatini 2003).

During the past two decades, however, urban growth patterns and the spatial distribution of population have changed. Increased investment in formal suburban housing developments, enclosed shopping centers, and big-box retail stores in urban peripheries has led to the suburbanization in Latin America (Borsdorf 2003; Biles 2008). Academic attention has focused mostly on the gated residential developments that are increasingly being built in the suburban areas of cities in Argentina (Libertun 2006; Janoschka 2002; Rios 2006), Chile (Salcedo and Torres 2004; Sabatini, Caceres, and Cerda 2001), and Brazil (Caldeira 2000; Coy and Pohler 2001). Scholars argue that the new patterns of

growth are exacerbating social disparity by reducing the geographic scale of segregation from large-scale patterns to smaller, unevenly distributed pockets of segregation.

The development of gated residential developments for high-income households is known as "fragmented" urban development (Vidal-Koppmann 2009), or "islands of wealth" (Janoschka 2002; Coy and Pohler 2002), as the majority of urban peripheries are still dominated by housing for low-income groups. Scholars argue that developers of these projects take advantage of the low land costs that prevail in poor peri-urban areas. Studies of gated housing developments in Buenos Aires and the three largest cities in Chile, for example, found that they have been built primarily in poor, peripheral municipalities (Libertun 2006; Sabatini, Caceres, and Cerda 2001).

Although walled residential areas for the wealthy have been built in the peripheries of some Mexican cities (Hiernaux-Nicolas 1999), new patterns of suburban development are quite different from those found in South American cities. The availability of mortgage finance for all formal, salaried employees from government housing finance agencies has increased exponentially since the mid-1990s, feeding a boom in the construction of large tract developments of single-family houses in the peripheries of cities across the country. These new suburban developments are quite different from those in other Latin American countries because they tend to be large, often with thousands of houses in one development, and because they are built for the middle- and working class, not the wealthy (Garcia Peralta and Hoffer 2006; Maya and Cervantes 1999).

It is likely that the new suburban developments in Mexico will lead to greater levels of segregation because they are comprised of homogeneous housing stock. Also, loans used to finance the purchase of the housing are available only to those employed in the formal sector. This type of urban development represents a shift away from the incremental urban development process through which cities in Mexico grew previously and will increase the importance of residential mobility in determining segregation patterns. In the United States, residential mobility is often considered as the dominant way in which cities were segregated. The dominant theories of segregation were developed in the early and mid-20th century and posited that as urban areas grow, households move into new, suburban neighborhoods as their incomes increased (Park 1957).

In the cities of Latin America, however, where residential mobility is relatively low, due in part to inefficient housing markets, social mobility frequently takes place *in situ* (Maloutas 2004; Rodríguez and Arriaga 2004). In these places, financially successful households tend to expand and consolidate their existing houses rather than move, and it is common to find large, multistory buildings next to the original shack a neighbor built upon inhabiting the lot thirty years earlier (Ward 2001). Ironically then, more efficient housing markets are likely to produce greater levels of socioeconomic segregation.

5.2.1 Drivers of Segregation

Scholars have identified a large number of factors that cause or exacerbate segregation. But quantitative analysis of segregation or its determinants in Latin America has been

lacking; thus this section draws on the study of segregation in the United States as well as on case studies that offer theories on the drivers of segregation in Latin America. Of course, the study of segregation in the United States is concerned with race, while in Latin America it refers to socioeconomic status. Nevertheless, much of the literature is relevant. In this section, the drivers of segregation are discussed in four groups: economic factors, urban growth factors, land-use factors, and housing-market factors.

Much of the Latin American segregation literature argues implicitly that inequality is not only a necessary condition for socioeconomic segregation, but also a cause of it (Schteingart 2001; Sabatini, Caceres, and Cerda 2001). The hypothesis that higher levels of inequality produce greater levels of segregation was explicitly tested in the one example of a comparative quantitative analysis of the drivers of segregation in a Latin America country. Telles (1995) analyzes the impact of industrialization and inequality on socioeconomic segregation in the 50 largest metropolitan areas of Brazil on segregation levels. He finds that in Brazil, segregation decreases with industrialization and increases with income inequality, and he argues that the impacts of industrialization are due to the decrease in income inequality that occurs when a city industrializes. Thus, in the present analysis, a measure of inequality and industrialization is included in addition to median household income.

The second and perhaps most fundamental driver of socioeconomic segregation is the size of a city. The mechanisms by which larger cities become more segregated have long been studied by both human ecologists and urban economists. Basically, as cities become

larger, they will tend to have greater commuting distances, larger disparities in land values, and more differentiated neighborhoods (Mills and Hamilton 1994; White 1986). These factors lead to increased segregation of economic groups due to their ability to pay for land and housing, preferences for land relative to commuting costs, and location-specific amenity packages such as public services and access to employment (Bayer, McMillan, and Rueben 2004; Dawkins 2005). In addition to the size of a city, its rate of growth can contribute to segregation by intensifying the demand for developed land in the short term. The importance of city size and growth rates in determining levels of segregation has also been noted in the literature on segregation in Latin America (Rubalcava and Schteingart 2000; Gonzalez Arrellano and Villeneuve 2006; Ariza and Solis 2009).

The third group, land-use factors, includes measures of the density of urban development, the distribution of density over the area encompassed by the city, and the spatial relationship between jobs and housing. The importance of urban land-use patterns in segregation outcomes was originally identified in relation to racial segregation in the United States and has generally focused on the link between zoning, land-use patterns, and segregation in U.S. cities (Pendall 2000; Quigley et al. 2004). A recent study by Galster and Cutsinger (2007), however, provides a more systematic treatment of the topic and theoretically links land-use to segregation through the standard monocentric city model. Though their focus is on segregation by race, they argue that all aspects of land use will affect segregation through itsimpact on the prices of land and housing. Thus,

land-use characteristics are more strongly connected to socioeconomic segregation than to racial segregation.

Theory predicts that the difference in a household's ability to pay for land will be greater in cities with higher overall densities, as high density creates higher land prices (Mills and Hamilton 1994). Thus, these cities should be more segregated by income. Galster and Cutsinger (2007) theorize that more centrality in land use, measured by steeper density gradients, will lead to less segregation due to the relationship between job and housing locations. They argue that some cities are less centralized and have multiple centers of employment, and that these centers attract employees based on the skill and qualifications needed, e.g. manufacturing centers versus business services centers. Therefore, employees of different skills and incomes will seek housing in different locations, leading to more segregation. Although Galster and Cutsinger (2007) theorize that the evenness of the distribution of jobs relative to housing should not necessarily affect land prices, it seems that a more uneven jobs/housing distribution will lead to higher transportation costs and thus higher land prices. This should also generate more segregation by income.

The fourth and final group is comprised of three measures of housing market characteristics. The first is the share of housing that is rented, which is used as a measure of housing market efficiency and intrametropolitan mobility. These factors are generally considered as important determinants of segregation in the cities of Latin America and Mexico (Duhau 2003; Luco and Vignioli 2003). Although more efficient housing markets are likely to exacerbate socioeconomic segregation due to income sorting, the effect of

rental housing on segregation is not clear. The increased residential mobility that rental housing generates could exacerbate segregation by allowing people to move near people similar to themselves; however, it could also ameliorate segregation by enabling people to move into neighborhoods that they otherwise would be priced out of. The second aspect of the housing market considered is the quality of the housing stock, the impact of which is also unclear. Finally, the share of recently built housing that was purchased with a mortgage is included, to capture the impact of the housing developments produced under the new housing finance system.

5.3 Recent Trends in Socioeconomic Segregation in Mexico

This section reports trends in income, segregation by income, and the share of income segregation conditional on the distribution of housing stock in Mexico's 128 metropolitan statistical areas (MSAs). Although the Mexican government defines metropolitan areas as those urban areas that encompass more than one municipality,[16] this excludes many large cities (Secretaría de Desarrollo Social, Consejo Nacional de Población, and Instituto Nacional de Estadísticas, Geografía e Informática 2004). Thus, for the purposes of this study, MSAs were defined using the definition from the United States census bureau - municipalities with an urban core of more than 50,000 people. By this definition, there are 128 MSAs inMexico, also referred to as cities in the paper.

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[16] Municipalities in Mexico are equivalent to counties in the United States. Mexico has no equivalent to incorporated cities.

Table 5.1 Median household income and percent high- and low-income households, 1990-2000

Variable	1990		2000		Percent change 1990-2000
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	
Median HH income†	3,670.01	944.73	3,085.63	852.56	-15.92
% High-income	13.99	5.69	11.15	4.65	-20.30
% Low-income	29.75	7.80	33.00	10.29	10.92

Source: INEGI (1990 and 2000a).
†Year 2000 pesos. [17]

In addition to housing finance reform and associated changes in urban development, Mexico also experienced a period of dramatic economic restructuring during the 1990s. The financial crisis that accompanied the signing of the North American Free Trade Agreement (NAFTA) in 1994 had a significant negative impact on economic growth and reversed the gains in income that had accrued during the early 1990s (Förster and d'Ercole 2005). Thus, the median household income declined during the 1990s. Table 5.1 reports the average median household income and the share of households classified as high and low income in later segregation analyses for the 128 MSAs in the country. High-income households are those that earn more than five minimum wages.[18] Low-income households are those earning one or fewer minimum wages.

[17] See www.banxico.org.mx for Consumer Price Index trends.
[18] In Mexico, income is often measured in multiples of minimum wages earned and is frequently reported categorically. In 2000, one minimum wage was 32.70 to 37.90 Mexican pesos, or 4.13 to 4.79 U.S. dollars, per day. The minimum wage varies by region.

5.3.1 Segregation by Income

Although median household income declined during the 1990s, socioeconomic segregation in Mexico, as measured by the entropy index, increased. The entropy index, originally developed by Theil (1972) and referred to as the information index, has been shown by several studies to be preferable to other measures of segregation (White 1986; Harsman and Quigley 1992; Reardon and Firebaugh 2002). It allows for the calculation of segregation measures for multiple groups, as well as the calculation of a conditional segregation measure. Essentially, the entropy index indicates the extent to which the composition of tracts deviates from the citywide composition of a given variable. It is generally expressed as the percentage difference between the existing distribution of groups and a completely even distribution. The formula can be found in Appendix A.

Table 5.2 reports three separate entropy indexes of income. The first two are two-group indexes that measure the distribution of high- and low-income households versus all other households. The third is a multiple group index that measures the distribution of income in six categories - households that reported: no income, less than one minimum wage, one to two minimum wages, two to three minimum wages, three to five minimum wages, and more than five minimum wages.

Table 5.2 Socioeconomic segregation as measured by the entropy index, 1990-2000

Entropy	1990		2000		Percent change 1990-2000
	Mean	Std. Dev.	Mean	Std. Dev.	
High-income	5.30	2.86	8.42	3.92	58.87
Low-income	2.36	1.49	3.46	1.43	46.61
Multiple categories	3.01	1.23	4.52	1.36	50.17

Source: Author's calculation with data from INEGI (1990 and 2000a).

Levels of income segregation as measured by the entropy index increased in almost every city in Mexico during the 1990s, by 50 percent on average. As noted by the entropy indexes for high- and low-income households, segregation of high-income households increased more than that of low-income households did.

5.3.2 Segregation by Income Conditional on Housing Quality

A first approximation to the importance of land use and housing in the segregation of socioeconomic groups in Mexico can be obtained by examining the extent to which segregation by income depends on the segregation of housing of different quality. This is done using a measure of conditional entropy, which has been used previously in research on segregation in the United States to examine the share of racial segregation that is explained by socioeconomic and demographic differences between racial groups (Harsman and Quigley 1993; Fischer 2003).

In order to calculate the share of income segregation that depends on the distribution of housing stock, four categories of housing stock quality are generated: i) consolidated, which means it is built of permanent materials[19] and has access to basic infrastructure[20], ii) built of permanent materials only, iii) built with access to basic infrastructure only, or iv) improvised, which means it is neither built of permanent materials nor has access to infrastructure. Table 5.3 reports the mean share of housing in these four categories for the 128 metropolitan areas in Mexico in 1990 and 2000.

Table 5.3 Categories of housing stock by level of consolidation, 1990-2000

	1990		2000		Percent change
Entropy	Mean	Std. Dev.	Mean	Std. Dev.	1990-2000
% Consolidated	46.11	16.07	52.34	19.21	13.53
% Infrastructure	10.68	9.35	13.86	12.86	29.77
% Permanent Materials	19.50	9.69	12.12	7.49	-37.84
% Improvised	23.71	11.16	21.67	12.97	-8.60

Source: INEGI (1990 and 2000a).

After housing quality categories are generated, households are classified into one of 24 categories obtained by combining the six income and four housing stock categories. The conditional entropy is then calculated using these categories. Conditional entropy can be understood as the difference between unconditional entropy by income and entropy by income conditional on housing as a fraction of unconditional entropy by income. The

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[19] Floors of cement or other permanent material, and a roof of masonry, concrete, clay tile, tiles of unspecified type, metal, or asbestos.
[20] Water piped to the household, connection to a sewage network or septic tank and electricity.

complete formula for can be found in Appendix B. Table 5.4 reports the entropy index of housing and the entropy index of income conditional on housing.

Table 5.4 Entropy of housing stock and income | housing, 1990-2000

	1990		2000		Percent change 1990-2000
Entropy	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	
Housing stock	18.31	6.11	19.92	6.55	8.79
Income | housing	47.99	8.56	50.27	10.63	4.75

Source: Author's calculation with data from INEGI (1990 and 2000a).

The level of segregation of housing stock, a multiple group index using the four groups mentioned previously, was more than three times higher than the index of segregation by income, though it increased by a much lower share during the 1990s. More importantly, however, almost half of the segregation of households by income depends on the segregation of housing of different levels of consolidation, as indicated by the conditional entropy measures. The average conditional entropy grew only slightly during the 1990s.

5.4. Determinants of Segregation and Conditional Segregation

This section presents models of the determinants of income segregation and the share of income segregation conditional on the distribution of the housing stock in 2000, as well as the changes in these two measures during the 1990s. The two sets of models test a series of hypotheses about factors that affect segregation levels. Table 5.5 reports

summary statistics for the explanatory variables used in the analysis; the four groups introduced in the previous theoretical discussion. Data come from two principal sources: microdata and cartography from the general census of population and housing (Instituto Nacional de Estadísticas, Geografía e Informática 1990, 2000a and 2000b), and the economic census of 1989 and 1999 (Instituto Nacional de Estadísticas, Geografía e Informática 1989 and 1999).

Table 5.5 Summary statistics of selected variables

Variable	Mean	Std. Dev.
Economic Factors		
% of jobs manufacturing, 1989	33.37	17.94
% of jobs manufacturing, 1999	31.09	16.68
Gini coefficient, 1990	61.81	3.50
Gini coefficient, 2000	58.80	4.81
Urban Growth Factors		
Population, 1990 (000,000s)	3.55	13.53
Population, 2000 (000,000s)	5.01	16.34
% growth in housing units, 90-00	48.77	20.60
Land-Use Factors		
Houses per hectare, 1990	34.29	13.41
Houses per hectare, 2000	46.87	18.13
Housing unit density gradient, 2000	-0.18	0.19
Dissimilarity, housing to jobs, 2000	47.94	9.73
Housing Market Factors		
% housing rented, 1990	19.24	5.43
% housing rented, 2000	29.61	5.94
% new houses financed, 95-99	23.93	16.99

Source: Author's calculations with data from INEGI (1989, 1990, 1999, 2000a, and 2000b) and CONAVI (nd).

The first of the economic factors, median household income, was reported in Table 5.1. The level of income inequality, as measured by the Gini coefficient, decreased during the 1990s, in spite of the decline in median household income. Although the actual number of manufacturing jobs increased significantly in many cities, the average share of jobs in the manufacturing sector declined in the 128 MSAs in Mexico. In terms of urban growth, the mean population of the MSAs in Mexico grew from roughly 350,000 to 500,000, which is reflected in the growth in the number of housing units, which was roughly 50 percent during the 1990s.

Housing unit densities increased by almost 40 percent during the 1990s, from thirty-four housing units per hectare to forty-seven. The housing unit density gradient was estimated in the standard manner, a log-linear model of housing unit density in a given census tract regressed on the distance in kilometers between that tract and the center of the city. The gradient is the coefficient on distance and is interpreted as the percent change in density at every kilometer one moves from the city center. The dissimilarity index of housing to jobs serves as an indicator of mixed-use development. It is the standard dissimilarity index from the segregation literature in the United States (Tauber and Tauber 1976). It measures the departure of the existing distribution of two groups, in this case jobs and housing are considered as being comparable units, from an even one across aerial units, in this case census tracts. The dissimilarity index can be interpreted as the percent of housing or jobs that would need to be shifted from its present location in order that each

tract contain an equal proportion of both. Unfortunately, the maps used to generate housing unit density gradients and the tract level employment data used to generate the indicator of mixed use are only available for the year 2000, thus a comparison of trends is not possible.

The average share of housing that is rented increased significantly during the 1990s, from 19 to 30 percent. The share of housing that is consolidated, as reported in Table 5.3, grew by 13 percent during the decade, which is logical given the incremental process through which housing is built in the country. On average, a quarter of the houses built between 1995 and 1999 in an MSA were purchased with a mortgage under the new housing system.

5.4.1 Regression Analysis of Segregation Levels in 2000

In order to test the determinants of segregation, two sets of ordinary least squares (OLS) regressions are run. In the first, the entropy of income and the entropy of income conditional on housing in 2000 are regressed on the groups of variables identified previously as drivers of segregation. The models take the form:

$$y = \beta_0 + x_1\beta_1 + x_2\beta_2 + x_3\beta_3 + x_4\beta_4 + \varepsilon$$

Where x_1 is a vector of the economic variables, x_2 is a vector of the urban growth variables, x_3 is a vector of the land-use variables, x_4 is a vector of the housing variables,

β_1–β_4 are the respective coefficients, β_0 is the constant term, y is the predicted value, and ε is the error term. Four models are run for the level of income segregation in 2000 and the level of income segregation conditional on the housing stock in 2000. The first three include the log of city size and the growth in housing units from 1990 to 2000, and one set of explanatory variables; first economic, then land-use, and finally housing. The fourth model consisted of all variables for which coefficients were significant in the first three models. Tables 5.6 and 5.7 report the results of the eight OLS regressions.

The coefficients in all models appear small, but this is due principally to the metric of the dependent variables, which is a percent and in the case of the entropy of income quite small, ranging from 0.02 to 0.09. In the case of the conditional entropy, it is larger, from 0.30 to 0.80.

Of the three sets of variables, the land-use and housing factors explain larger shares of the variation in segregation levels than economic factors, and two of three variables are significant in these groups (Models 2 and 3). Thus, in addition to city size, it seems that variation in the structures of the cities' built environments in Mexico is more important in determining socioeconomic segregation than the characteristics of their residents. The size of the city is consistently the most important determinant of the level of segregation. Contrary to theoretical predictions, however, the recent growth rate of housing units is not significantly associated with higher levels of segregation.

Table 5.6 OLS regression results: Entropy of income 2000 (N = 128)

Variables	Models			
	1	**2**	**3**	**4**
ln (Population)	0.008	0.006	0.007	0.006
	[0.002]***	[0.002]***	[0.001]***	[0.001]***
% Change in	0.003	-0.002	0.009	
housing 90-00	[0.006]	[0.007]	[0.005]	
ln(Median HH	-0.000			
income)	[0.005]			
% Jobs manuf.,	-0.012			-0.016
1999	[0.006]**			[0.005]***
Gini	0.028			
	[0.023]			
ln(Hsg. density)		0.001		
		[0.003]		
Hsg. gradient		0.009		0.007
		[0.003]**		[0.002]***
Mixed-use		0.032		0.031
		[0.010]***		[0.010]***
% Hsg. rented			-0.070	-0.053
			[0.016]***	[0.016]***
% Hsg.			0.003	
consolidated			[0.006]	
% New hsg.			0.012	0.013
financed, 95-99			[0.006]*	[0.005]**
Constant	-0.072	-0.051	-0.028	-0.022
	[0.038]*	[0.019]	[0.016]*	[0.013]
R-squared	0.39	0.43	0.47	0.54
Adj. R-squared	0.36	0.40	0.45	0.52
F	15.48	17.59	21.96	28.31

Table 5.7 OLS regression results: Entropy of income | housing stock, 2000 (N = 128)

Variables	Models			
	1	**2**	**3**	**4**
ln (Population)	0.025	0.032	0.011	-0.001
	[0.010]**	[0.014]**	[0.007]	[0.007]
% Change in housing 90-00	-0.122	-0.081	-0.011	-0.044
	[0.060]**	[0.044]*	[0.036]	[0.046]
ln(Median HH income)	0.196			0.074
	[0.041]***			[0.044]*
% Jobs manuf., 1999	0.007			
	[0.050]			
Gini	-0.123			
	[0.213]			
ln(Hsg. density)		0.051		0.011
		[0.023]**		[0.016]
Hsg. gradient		-0.056		0.030
		[0.034]*		[0.023]
Mixed-use		0.300		-0.305
		[0.106]***		[0.145]**
% Hsg. rented			-0.001	
			[0.125]	
% Hsg. consolidated			0.247	0.270
			[0.058]***	[0.049]***
% New hsg. financed, 95-99			0.256	0.172
			[0.059]***	[0.057]***
Constant	-1.238	-0.205	0.186	-0.335
	[0.283]***	[0.164]	[0.097]*	[0.335]
R-squared	0.38	0.22	0.63	0.68
Adj. R-squared	0.36	0.19	0.61	0.66
F	15.52	5.69	41.11	35.69

Of the economic variables, median household income and the Gini coefficient of income inequality are not significantly associated with segregation levels. However, manufacturing employment as a share of a city's employment is, and the coefficient is negative as predicted. The impact, however, is not large. Telles (1995) found that manufacturing employment also negatively impacted segregation in Brazilian cities; however, the impact of industrialization on segregation was due to its influence on levels of income inequality. This is not the case in the present analysis. One possible reason for the difference between the Brazilian and Mexican case is that the data used in Telles study of Brazil are from 1980. Industrialization's impact on inequality has likely diminished over the years as it has become a more common source of employment in Latin America.

Two of the land-use variables, the housing gradient and a measure of the spatial distribution of jobs versus housing, are statistically significant. The positive coefficient on the density gradient indicates that the more rapidly density declines as one moves away from the center of the city, i.e. the more centrality, the lower segregation by income. This fits the theoretical prediction of less segregation due to the impact of centrality of employment on residential location decisions. The positive coefficient on the measure of mixed use also follows theory as it indicates that the greater the level of job/housing dissimilarity, or the less jobs and housing tend to co-locate, the greater the segregation. Theoretically, this is due to the higher transportation and land costs the separation of jobs and housing implies.

Two housing market variables are significant predictors of segregation levels. The percent of a city's housing stock that is rented is negatively associated with segregation, which suggests that the availability of rental housing leads to households moving to neighborhoods where they would be unable to own due to high prices. The more important housing market characteristic, the share of new housing that was purchased with mortgages, is positively associated with segregation. Thus, the new patterns of urban development in Mexican cities are in fact a significant determinant of segregation.

In the second set of models, in which the level of conditional segregation is regressed on the same four groups of explanatory variables, the share of housing purchased with a mortgage is also statistically significant and positive. The rest of the determinants, however, have very different impacts on conditional segregation. Rental housing is not significant, but the share of housing stock that is consolidated is. This is to be expected, as the shares of housing of different conditions is an important component of the measure of conditional segregation. In this case, cities with greater shares of consolidated housing have a greater share of income segregation that is conditional on the distribution of housing stock.

Of the economic variables, median household income is a significant and positive determinant of conditional entropy. When only the urban growth and land-use variables are included (Model 2), all the land-use variables are significant; however, when the housing market variables are also included in the final model (Model 4), only the measure of mixed use retains significance. The level of mixed use as measured by a

jobs/housing dissimilarity index has the opposite impact on the conditional entropy of income than it did on the entropy of income, and the impact is large. Thus, less of the segregation by income depends on the distribution of housing stock in cities with more separation between jobs and housing.

5.4.2 Regression Analysis of Changes in Segregation

The second set of models regress the entropy of income and the entropy of income conditional on housing in 2000 on the changes in the previously tested determinants during the 1990s. These models include the entropy of income and income conditional on housing in 1990 on the right-hand side, which makes them models of the determinants of change in levels of segregation. Coefficients on the right-hand side of the equation can be interpreted as the impact in changes in variables on levels of segregation in 2000 given the level of segregation of 1990. They take the form:

$$y_{00} = \beta_0 + y_{90}\beta_1 + x_1\beta_2 + x_2\beta_3 + x_3\beta_4 + \varepsilon$$

Where x_1 is a vector of the changes in economic variables, x_2 is a vector of the changes in urban growth variables, x_3 is a vector of the changes in housing variables,[21] β_2–β_4 are the respective coefficients, β_0 is the constant term, y_{00} is the predicted value, and ε is the error term. In contrast to the previous model, this model controls for the level of segregation or conditional segregation in 1990, y_{90}. Again, four models are run for the level of income

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[21] Unfortunately, other than overall housing unit density, measures of the land-use variables are not available for 1990. Thus, in this case, density is included with the housing variables.

segregation and the level of income segregation conditional on the housing stock. The first three models include the level of segregation or conditional segregation in 1990, the number of new housing units added in the city between 1995 and 2000, the share of these units that were purchased with financing, and one set of explanatory variables, either economic, land use or housing. The fourth model includes the variables for which coefficients were significant in the first three models.

Tables 5.8 and 5.9 report the results of the eight OLS regressions. Not surprisingly, in both sets of models, the ten-year lagged dependent variable is a strong, positive determinant of the entropy of income and the entropy of income conditional on housing in 2000, and the R-squared values of the models are high, between 0.65 and 0.78.

The log of the number of houses built from 1995 to 2000 is a significant determinant of the change in segregation from 1990 to 2000. This mostly reflects the size of a city as the two variables are very highly correlated (Spearman correlation coefficient of 0.95). The log of the number of houses is only a significant determinant of the change in conditional segregation when controlling for changes in the quality of a city's housing stock (Models 3 and 4) and the coefficient is negative. Thus cities that have added more housing, generally the larger cities, have seen the share of income segregation conditional on the distribution of the housing stock decrease.

Table 5.8 OLS regression results: Changes in entropy of income, 1990-2000 (N = 128)

Variables	Models			
	1	**2**	**3**	**4**
Entropy of Income, 1990	0.695 [0.121]***	0.713 [0.116]***	0.702 [0.133]***	0.707 [0.123]***
Entropy of Inc.|hsg., 1990				
New hsg. 95-99	0.003 [0.001]**	0.003 [0.001]**	0.003 [0.001]**	0.003 [0.001]**
% New hsg. financed, 95-99	0.009 [0.004]**	0.010 [0.004]**	0.008 [0.004]*	0.009 [0.004]**
% Chg. Median HH inc.		-0.010 [0.007]		
% Chg. Share jobs manuf.		0.000 [0.002]		
% Chg. Gini		0.008 [0.011]		
% Chg. hsg. Density			0.001 [0.003]	
% Chg. Share hsg. Rented			0.004 [0.003]	
% Chg. Share Consolidated			-0.005 [0.002]***	-0.004 [0.001]***
Constant	-0.006 [0.010]	-0.006 [0.011]	-0.007 [0.010]	-0.003 [0.010]
R-squared	0.65	0.65	0.67	0.66
Adj. R-squared	0.64	0.64	0.65	0.64
F	75.17	38.15	40.81	55.94

Table 5.9 OLS regression results: Changes in entropy of income | housing, 1990-2000 (N = 128)

Variables	Models			
	1	**2**	**3**	**4**
Entropy of Income, 1990				
Entropy of Inc.|hsg., 1990	0.890	0.873	0.958	0.957
	[0.104]***	[0.102]***	[0.085]***	[0.085]***
New hsg. 95-99	-0.009	-0.009	-0.013	-0.013
	[0.006]	[0.007]	[0.006]**	[0.006]**
% New hsg. financed, 95-99	0.142	0.144	0.119	0.131
	[0.052]***	[0.052]***	[0.049]**	[0.046]***
% Chg. median HH inc.		0.052		
		[0.057]		
% Chg. share jobs manuf.		-0.001		
		[0.013]		
% Chg. Gini		0.065		
		[0.077]		
% Chg. hsg. density			-0.015	
			[0.021]	
% Chg. share hsg. rented			0.005	
			[0.013]	
% Chg. share consolidated			-0.057	-0.058
			[0.019]***	[0.018]***
Constant	0.136	0.153	0.157	0.150
	[0.062]**	[0.067]**	[0.065]**	[0.061]**
R-squared	0.73	0.74	0.77	0.78
Adj. R-squared	0.73	0.73	0.76	0.76
F	114.10	56.95	66.30	120.68

Other than city growth and the ten-year lag of entropy and conditional entropy, only two variables are statistically significant in the models: the percent of new housing purchased with financing and the percent change in the share of housing that is consolidated. Unlike the impacts of determinants of levels of segregation and conditional segregation, the coefficients of determinants of changes in these two measures are similar. The greater the share of new housing purchased with financing led to both higher levels of income segregation and a higher share of income segregation conditional on the distribution of housing. Cities in which the share of consolidated housing increased experienced a decline in the level of segregation and conditional segregation. These two coefficients suggest that countervailing forces are at work in the relationship between segregation and urban development in Mexico. More homogenous, segregated neighborhoods are being built under the new housing finance system, compared with the traditional system of incremental housing development in which the consolidation of housing reflects social mobility *in situ* and is associated with lower levels of segregation. More detailed research on residential moves and neighborhood change is needed to confirm this conclusion.

5.5 Conclusion

This paper argues that by altering patterns of urban development in Mexico, the new housing finance system has exacerbated socioeconomic segregation. Yet it is not intended to denounce the reform and expansion of housing finance. Rather, by assessing the unintended consequences of the housing developments built under the new system, it

seeks to inform academics and policymakers so that future reform of the housing finance system can consider the secondary impacts of the policy.

The question remains, however, as to how important a consideration socioeconomic segregation is for housing policy. There is disagreement over the importance of mixed-income neighborhoods within the fields of urban economics, planning and policy studies. Urban economics often refers to socioeconomic segregation as "natural segregation" as it is the degree of separation between different economic groups that is determined by the market (Mills and Hamilton 1994) and is thus efficient. In fact, in the classic paper on neighborhood sorting based on local amenities, Tiebout (1954) argues that residential sorting between small units of local government is also the most efficient way to organize public services.

However, there is compelling evidence that concentrated poverty has negative effects, at least in the United States (Massey and Denton 1993; Wilson 1987). Thus, scholars and practitioners have begun to argue forcefully for policy that promotes mixed-income housing developments and neighborhoods. A recent review of the literature on mixed-income housing (Joseph 2006) outlines in detail the theory and evidence on the ways in which mixed-income areas are beneficial to their lower-income residents and society as a whole. More work is needed to assess the relevance of these arguments in the case of Mexico and Latin America in general.

Nevertheless, policymakers should begin to consider the trade-offs between the cost reductions that stem from building large and homogenous housing developments and the negative impacts of more segregated suburban spaces. It seems that imposing some restriction on the number of equally priced units that can be built in one development or a limit on the size of contiguous housing developments would not be an excessively harsh policy in order to promote social mixing.

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Appendix A

Clustering

The local Moran's I is a decomposition of the global Moran's I, defined as:

$$I_i = \frac{nZ_i}{\sum_i^n Z_i^2} \sum_{j=1}^n W_{ij} Z_j$$

Where Z_i is the deviation of X from its mean, and W_{ij} is a matrix of spatial weights.

The global Moran's I is defined as:

$$I = \frac{N}{\sum_i \sum_j W_{ij}} \frac{\sum_i \sum_j W_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2}$$

Where N is the number of spatial units indexed by i and j, X is the variable of interest, $\bar{X}$ is the mean of X, and W_{ij} is a matrix of spatial weights.

Evenness

The index of dissimilarity is defined as:

$$D = \frac{1}{2} \sum_{i=1}^n \left| \frac{xi}{X} - \frac{yi}{Y} \right|$$

Where x_i is the number of people of group X in tract i; X is the total number of people in group X; y_i is the number of people of group Y in tract i; and Y is the total number of people in group Y.

The segregation measure of entropy, the reduction in entropy arising from unequal distributions across units, is defined as:

$$S = \sum_{i=1}^n \left[\frac{ti(H - Hi)}{HT} \right]$$

Where t_i is the proportion of the population in tract i, T is the total population, H_i is the entropy of tract i, and H is the entropy of the city. The city's entropy is defined as:

$$H = (X) \log \left[\frac{1}{X} \right] + (1 - X) \log \left[\frac{1}{1-X} \right]$$

A tract's entropy is similarly defined as:

$$Hi = (xi)\log\left[\frac{1}{xi}\right] + (1 - xi)\log\left[\frac{1}{1 - xi}\right]$$

Exposure

The most frequently used measure of exposure, xP*y, is defined as:

$$xP^*y = \sum_{i=1}^{n}\left[\frac{x_i}{X}\right]\left[\frac{y_i}{t_i}\right]$$

Where x_i , X, y_i and t_i are defined as previously.

Centralization

The Absolute Centralization Index (ACI) is defined as:

$$ACI = \left(\sum_{i=1}^{n} X_{i-1}A_i\right) - \left(\sum_{i=1}^{n} X_i A_{i-1}\right)$$

Where the census tracts are ordered by distance from the center of the city, A_i is the cumulative proportion of land area through unit i. X_i is the cumulative proportion of population group X in tract i.

Concentration

Delta is defined as:

$$DEL = \frac{1}{2}\sum_{i=1}^{n}\left|\left[\frac{x_i}{X} - \frac{a_i}{A}\right]\right|$$

Where x_i and X are defined as before, a_i is the land area of unit i and A is the total land area in the city.

Appendix B

Multi-group Entropy Index

The aggregate entropy of income based on six income groups, H(Y), is the sum of the entropy of each tract, weighted by the proportion of the population in that tract.

$$\bar{H}(Y) = \sum_{t=1}^{n} w_t \left[\sum_{y=1}^{6} p_{yt} \log \left[\frac{1}{p_{yt}} \right] \right]$$

Where w_t is the proportion of the population in tract t, and p_{yt} is the proportion of households in tract t in income group y. The maximum entropy of the city is calculated based on the city-wide proportions of households in each income bracket.

$$H(Y) = \sum_{y=1}^{6} p_y \log \left[\frac{1}{p_y} \right]$$

Thus, the entropy index, S, is calculated as the reduction in entropy that occurs based on the unequal distribution of income groups across tracts.

$$S = \frac{(H(Y) - \bar{H}(Y))}{H(Y)}$$

Conditional Entropy

The average conditional entropy of income (in six categories) given the distribution of housing conditions (in four categories) is denoted $\bar{H}_c(Y)$, and calculated based on the 24 categories of income and housing, according to the formula for conditional entropy:

$$\bar{H}_c(Y) = \sum_{t=1}^{n} w_t \left[\sum_{Y=1}^{6} \sum_{C=1}^{4} p_{yct} \log \left[\frac{p_{yt}}{p_{yct}} \right] \right]$$

Where, as before w_t is the proportion of the population in tract t, p_{yt} is the proportion of households in tract t in income group y, and p_{yct} is the proportion of households in tract t that are in income group y and housing stock category c.

The index of conditional entropy, I, is the difference between the unconditional entropy by income and the entropy of income conditional upon housing, expressed as a fraction of unconditional entropy of income.

$$I = \frac{(\bar{H}(Y) - \bar{H}_c(Y))}{\bar{H}(Y)}$$

This value would be zero if the distribution of income and housing were independent.