UCF College of Business Administration

Dr. P. Phillips School of Real Estate

Property Rights and Urban Development: Initial Title Quality Matters Even When it No Longer Matters*

Ignacio A. Navarro
California State University at Monterey Bay
inavarro@csumb.edu

and

Geoffrey K. Turnbull
University of Central Florida
gturnbull@bus.ucf.edu

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Abstract. Formal title to property allows owners to borrow for investing in improvements. Title legalization laws, however, appear to yield only modest increases in housing quality in developing countries. We offer a simple model in which squatters initially balance initial investment in low quality structures to reduce the risk of eviction against the future effect of increasing the marginal cost of improving quality. The effort to secure initial possession thereby creates a legacy effect, reducing subsequent investments in housing quality. Empirical tests using Bolivian data yield results consistent with the legacy theory: initial title risk suppresses long run housing quality.

JEL Codes: K11, R14, R21

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1. Introduction

Most economists believe that the lack of formal title to property impedes efficient urban development. The security of formal title creates an incentive for owners to invest in improvements, but it also allows erstwhile squatters to tap their property as a source of capital by using it as collateral for loans (de Soto, et al., 1989; de Soto, 2000). This compelling notion underlies efforts by several developing countries to formalize titles to property obtained by informal market transactions, whether through squatting or land invasion or through illegal but consensual transactions. These titling programs, however, appear to yield only modest increases in beneficiaries' use of available loans to upgrade housing quality. For example, fewer than a quarter of households receiving formal titles use bank loans to upgrade their houses in Peru (Calderon, 2003) while only 4% took out mortgage loans in a former squatter settlement in Argentina (Galiani and Schargrodsky, 2006). Both of these studies report that the beneficiaries of the titling programs paid for their modest housing upgrades from their own resources rather than private loans, behavior that precludes the more extensive improvements in housing quality that could have been attainable.

The modest effect of title regularization on loans undertaken for upgrading housing is somewhat puzzling and has even been portrayed as a "mystery" that appears to fly in the face of the notion that it is the absence of verifiable formal property rights that inhibits investment in higher quality housing (*The Economist*, 2006). Once this barrier is lifted by providing clear property titles, upgrading should occur at a relatively rapid pace. The contradictory evidence, however, suggests that legalizing titles is not sufficient to stimulate neighborhood upgrading (Brakarz, Green and Rojas, 2002).

This paper begins with the premise that the previous focus on borrowing for upgrading may obscure some of the fundamental economic forces at work. After all, the low level of borrowing for upgrading may not reflect reluctance by erstwhile squatters to use their now securely titled property as collateral, but instead may simply reflect a more modest demand for property improvements. Taking this notion as a starting point, this paper examines the property upgrading decisions that squatters and other owners of property settled as illegal developments face after they receive formal property title. We develop a simple model drawing from the recent squatter settlements literature to explain why title security at the time of settlement affects its future upgrading capacity even long after it has been legalized. In our model, the initial housing investment decision of squatters balances the effect of increasing their density of low quality structural capital to reduce the risk of eviction against the future effect of increasing the marginal cost of later improvements. The effort to secure initial possession therefore creates a legacy effect that reduces subsequent investments in housing quality improvements.

We use data from Cochabamba, Bolivia, to empirically test the predicted long term relationship between the legal status of the initial settlement and subsequent housing quality. We find that the housing quality mix across neighborhoods varies with the title security and underlying eviction risks when the areas were originally settled; the current proportion of high quality units increases with title security at the time of the settlement. In addition, income tends to have a lower marginal effect on housing quality in (originally) illegal settlements than it does in comparable legal settlements. These results indicate that, while granting formal property title may eliminate vestiges of possessory risk, it apparently does not remove the legacy effect of the initial development pattern on subsequent redevelopment; the security of property rights at the time of settlement has lasting effects on the subsequent quality of housing.

The rest of this paper is organized as follows. The second section presents a stylized model of the squatter's initial investment and subsequent housing upgrades to establish the link between the initial quality of property title and housing quality after title formalization has been established. The third section explains the setting used in the empirical study, Cochabamba, Bolivia. The fourth section explains the data and empirical models while the fifth section reports the empirical results. The final section concludes.

2. Initial Title Quality and Subsequent Housing Quality

Much of the theoretical literature explaining informal settlements and urban development focuses on how the threat of taking or eviction influences the initial structural density or quality of urban residential development. Part of this literature concentrates on the dynamic effects of insecure property rights arising from public sources like land use regulations and takings by governments, or private sources like squatters and adverse possession. Turnbull (2005) argues that ownership risks arising from private sources (like squatters) tend to prompt developers to adopt greater structural density, especially in outlying urban locations where the highest and best formal sector future uses call for decreasing structural density over time. Other models of squatting embody a similar relationship between ownership risk and structural density for land successfully taken by squatters: greater initial investment in housing capital by squatters increase the legal land owner's costs of land clearing and therefore decreases the probability of eviction (Jimenez, 1985; Jimenez and Hoy, 1991; Turnbull, 2008).[1]

All of this literature envisions the squatter's housing investment decision as a one-time choice made when the area is initially settled. In contrast, we present a stylized multistage

[1] Brueckner and Selod (2009) instead assume that the squatters pay bribes to government officials to reduce the probability of eviction by owners.

decision model that draws out the connection between initial settlement structural density and subsequent investment in upgrading housing quality once title has been secured.

Consider a representative squatter's investment decisions for a unit size land parcel. Assume that the squatter makes two housing investment decisions—how much (low quality) structure, S, to build at the outset and then how much quality improvement, Q, to pursue once the threat of eviction has abated. The squatter's enjoyment or value derived from the land developed with low quality structure S is given by the increasing strictly concave $U(S)$ during the period in which the settlement is being established. The probability that the squatter will not be evicted by the property owner during the period of settlement is $p(S)$. Following Jimenez (1985), Jimenez and Hoy (1991) and Turnbull (2008), greater initial structural density decreases the probability of eviction so that $p' > 0$.

Once the settlement is established and the eviction threat eliminated, the squatter chooses quality improvements Q and incurs cost $C(Q,S)$. The marginal cost of improvements is positive and increasing ($C_Q > 0$ and $C_{QQ} > 0$). The presence of the initial low quality structure, however, affects the cost of subsequent improvements, with greater initial structural density impeding subsequent upgrades by increasing the cost of quality improvements ($C_S > 0$, $C_{QS} > 0$). The squatter's enjoyment or value of the real estate with quality improvements Q is given by the increasing strictly concave $V(Q)$.

Ignoring time discounting without loss of generality, the representative squatter's expected value of initial structural density investment S and subsequent improvements Q is

$$I = U(S) - S + p(S)[V(Q) - C(Q,S)] + (1 - p(S))u \qquad (1)$$

where the price of S is one and u is the squatter's utility if evicted from the property—the latter being the equilibrium utility from returning to the agricultural hinterland from which the squatter migrated to the urban area. The squatter's strategy satisfies the conditions

$$I_S = U' - 1 + p'[V(Q) - C(S,Q) - u] - pC_S = 0 \tag{2}$$

$$I_Q = p[V' - C_Q] = 0 \tag{3}$$

The squatter's choice of initial structural density balances the marginal benefit, in the form of increase in initial period net value ($U' - 1$) and the increase in expected future value from the reduced probability of eviction $p'(V\text{-}C\text{-}u)$, against the marginal cost, in the form of the increased cost of future improvements pC_S. The choice of future quality balances the marginal benefit and marginal cost of quality, $V' = C_Q$., conditional on the prior choice of initial structural density.

In order to examine the relationship between the squatter's optimal $\{S^*,Q^*\}$ and the underlying possessory risk, we introduce a possession risk shift parameter r into the probability $p(S;r)$, where $p_r < 0$ and $p_{Sr} \geq 0$ together reflect our assumption that higher values of the r index indicate greater underlying exogenous risk of eviction at all levels of initial structural density. Totally differentiating the squatter's optimality conditions and solving for the comparative statics in the usual way yields

$$\frac{\partial S^*}{\partial r} = \frac{[p_{Sr}(V - C - u) - p_r C_S]C_{QQ}}{I_{SS}I_{QQ} - \left(I_{SQ}\right)^2} > 0 \tag{4}$$

$$\frac{\partial Q^*}{\partial r} = \frac{-[p_{Sr}(V - C - u) - p_r C_S]pC_{QS}}{I_{SS}I_{QQ} - \left(I_{QS}\right)^2} < 0 \tag{5}$$

where the signs follow from $V\text{-}C\text{-}u > 0$ and the concavity of $I(S,Q)$. These results establish the key relationships examined in the empirical analysis: *Greater initial title insecurity increases the initial density of low quality structures and creates a legacy effect that reduces the ultimate quality of improvements undertaken after title security has been attained.*

Intuitively, the squatter responds to the greater risk of eviction by investing more in the initial structure to reduce the risk of eviction and increase the probability of retaining ownership of the property. The greater structural density, however, increases the cost of future improvements, which in turn reduces the incentive to improve housing quality even after title has been secured. The different types of informal settlements in our study area of Cochabama, Bolivia, engender different underlying possessory risks for settlers. Therefore, the above predictions lead us to expect to find different housing quality characteristics for otherwise identical neighborhoods occupied by owners with legal title, with housing quality varying according to the title conditions and underlying eviction risks when the areas were originally settled. Subsequent title formalization, while eliminating any last vestiges of ownership risk from original title quality, does not erase the legacy effect of the initial development pattern on subsequent redevelopment or improvements. As a result, we expect to find more modest investment responses from title regularization for precisely those properties whose original titles were least secure.

3. The Study Setting

The city of Cochabamba is located in the low valleys of Bolivia. Founded in 1574, the city is the third largest urban center in the country. Its development patterns differ modestly from that of

other Bolivian cities. The first significant expansion in Bolivian cities coincided with a wave of rural-urban migration over 1900-1950 as Bolivia's rural peasants moved into cities looking for better living conditions. In the case of Cochabamba, the rapid growth taking place during this period prompted the local government to undertake a comprehensive plan to regulate the pace of development. The first master plan, instituted in 1946, was to regulate urban growth for the next 50 years (Goldstein, 2004). The plan was unable to contain the population growth and the pressure on available land for development, so by 1951 the city experienced its first violent occupation of land. The squatters successfully resisted the eviction attempts of the municipal authorities and the first squatter settlement was created on what was then the southeastern outskirts of the city. Other land invasions took place soon after with varying degrees of success and soon after the city experienced a second strategy of land occupation: illegal subdivision, or the development of land by legal owners in contravention of current laws. Between 1945 and 1976, about 10 percent of the land being developed in the city occurred either through land invasions on public or private land or through illegal subdivisions of rural land.

By the 1970's such informal land development began to be recognized as a problem at the national level and Bolivia's central government responded by enacting public programs to provide housing for the poor at affordable prices. These programs, however, were ineffective and costly due, in part, to government corruption (Solares and Bustamate, 1986). For the most part, these programs were reduced to simple efforts to regularize the legal status of previously illegally settled plots of land or promises of future land transfers that ultimately never took place (Goldstein, 2004).

Between 1976 and 1992, amidst the failure of affordable housing policies at the national level, the city experienced the highest population growth rates in its history from a second wave

of in-migration from the rural sector. The city almost doubled its developed area during this period; 30 percent of that new development did not comply with existing laws and was mostly undertaken by *loteadores* (illegal land brokers) who subdivided and sold land reserved for agriculture. The municipal government's first reaction to this practice was to bulldoze new illegal development, but the persistence of the illegal settlers made the policy costly in terms of both economic resources and political capital (Solares, 1999).

Cochabamba's population growth over 1992-2001 continued at a rapid pace, but by this time almost all of the land reserved for formal development had been occupied. As a result, about 70 percent of the area developed during this period was accomplished through illegal land subdivision. Some of the illegal subdivisions took place in land reserved for agriculture while others occurred on privately owned land within areas designated as national parks.

To this day, illegal land subdivision remains one of the main ways that land is developed in Cochabamba. A large portion of old illegal subdivisions and virtually all of the older squatter settlements have been legalized through many title regularization programs over time. The latest land regularization undertaken in 2002 followed the same lines as previous efforts, and, as before, the central government promised that this one would be the last. Perhaps not surprising, this promise has not slowed the rapid pace of illegal growth (Farfan, 2004).

4. Data and Empirical Models

To test the theoretical model predictions, we use geo-coded data for the 6,415 city blocks covered in the 2001 Bolivian National Census. The theoretical model predicts that, other things being equal, the proportion of homes of a particular housing quality level in a settlement is a function of the land occupation strategy undertaken at the time of origin, or more formally:

$$Q_{ji} = \alpha + \boldsymbol{s}_i \lambda_j + \boldsymbol{w}'_i \varphi_j + \varepsilon_i \quad (6)$$

where Q_{ji} is the proportion of homes of quality j in block i in 2001, $\boldsymbol{s}$ is a vector of binary variables identifying the level of title security at the time of original settlement of block i, $\boldsymbol{w}$ is a vector of city block characteristics believed to have an impact on the quality of housing in block i, ε is a stochastic disturbance term, and $\boldsymbol{\lambda}$, $\boldsymbol{\varphi}$ are the parameters of interest to be estimated.

The theoretical model predicts that the quality of title at the time a city block is originated determines the quality of housing at a later point in time (i.e., $\boldsymbol{\lambda_j} \neq 0$ in (6)). In other words, the trajectories of housing redevelopment or upgrading are a function of quality of title at the origin. We further test this proposition by examining how effect a city block's original title quality affects the subsequent change in construction quality using a sample of city blocks from the 1992 Bolivian National Census, or more formally:

$$\boldsymbol{\Delta HQ_i} = \boldsymbol{\gamma} + s_i \boldsymbol{\beta} + \boldsymbol{\Delta x'_i \delta} + y'_i \boldsymbol{\zeta} + z'_i \boldsymbol{\theta} + d' \boldsymbol{\mu} + \boldsymbol{\varepsilon_i} \quad (7)$$

where ΔHQ_i captures the change in the percentage of homes of high quality in city block i between 1992 and 2001; $\boldsymbol{s}$ is a set of binary indicators identifying block i's land occupation strategy, $\boldsymbol{\Delta x}$ is a vector of the change in block i's characteristics between 1992 and 2001 believed

to affect upgrading investments; ***y*** is a vector of block *i's* location attributes; ***z*** *and* ***d*** are vectors of block attributes in 1992 and 2001 respectively, believed to influence investments in property upgrading between 1992 and 2001; ε is a random disturbance term; and $\beta, \delta, \zeta, \theta,$ *and* μ are parameters to be estimated by the model.

Housing quality measures: The housing quality definition used here follows that of the Bolivian Institute of Statistics. This definition classifies a particular home to be of low, medium, or high quality according to the construction materials used in the walls, roof and floor.[2] The dependent variables for the empirical model (6) are the proportion of homes falling into the separate quality ranges in a particular city block, while the dependent variable for model (7) is the change in the percentage of high quality homes in a block from 1992 to 2001.

Title quality at settlement origination: The quality of property title at the time of original occupation is the key independent variable in this study. To construct a measure of title quality, we obtained information on each type of settlement and classified them by legal origin using official municipality maps reflecting the city master plans in 1945, 1961, 1977, and 1998 and the expert advice of urban historian Humberto Solares.[3] This procedure identified 6 different settlement types that vary in the degree of title security at the time of settlement and therefore in the predicted quality of structure at the time of origin. The 6 types of settlements are described below in ascending order of title security. Their locations in the urban area are indicated in figure 1.

[2] The appendix explains in greater detail how this variable is constructed.

[3] Professor Solares of San Simon University is a widely recognized South American urban historian and is the author of several books and influential professional reports on Cochabamba urban history, including Solares (1990, 1999) and Solares and Bustamante (1986).

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Squatter settlements encompass settlements that originated as violent land invasions. These land invasions took place against laws of property and urbanism at the time of settlement. Squatter settlers faced the highest probability of eviction at the time of settlement. As a result, we expect squatter settlements to have the highest density of low quality initial structures at the time of origin and therefore to experience lower upgrading rates than comparable settlements that had a lower probability of eviction at the time of origin. In the city of Cochabamba, squatter settlements grew during 1945-1976 in the southeastern part of the city indicated in figure 1.

Illegal land subdivisions involve settlements in which the land originally sold under a consensual agreement between owner and buyer, but were developed in violation of laws of urbanism at the time of settlement. Because there is a consensual transfer of property rights in this type of settlement, this strategy is expected to face little or no probability of eviction by the legal owner of record and a lower probability of eviction by government authorities than that of a violent invasion. Therefore, our model would predict that informal land subdivisions would upgrade at a higher rate than squatters but at a lower rate than settlements originated legally.

We further distinguish between two types of neighborhoods developed under this modality: development undertaken between 1976 and 1992 in the southeastern part of the city, and development undertaken between 1993 and 2001 in the southern part of the city, as indicated in figure 1. The former group faced fierce opposition from local authorities but received clean property titles in the late 1990's (and labelled "now legal" in our empirical model). Illegal settlements in the later group (labelled "still illegal" in our empirical model) were settled as the

municipality began recognizing the older illegal subdivisions as eligible for regularization, but are still in the process of obtaining legal titles.

Government supported settlements constitute settlements that developed, for the most part, under the same conditions as squatters (i.e. non-consensual and in violation of urbanism and property laws) but differ somewhat because these settlers had the support of a government official in the national housing ministry—but not local government support. In this sense, the initial development strategy was similar to that of squatters (i.e., high structural density), but because these settlements had a certain degree of recognition from a government official, they had a lower perceived threat of eviction than squatters at the time of settlement.[4] Thus, this settlement type is expected to have a greater upgrading rate than that of comparable squatter settlements but less than comparable settlements that originated in the formal sector or under other informal modalities.

Illegal land subdivisions in protected areas involve settlements in which the land sold under a consensual agreement between owner and buyer but developed in violation of municipal and national laws since they took place in protected national parks. At the time these areas were declared protected national parks they were privately owned by farming communities. The national park regulation did not expropriate these plots per se, but restricted land use to certain types of agriculture and forestry. As the northern part of the city grew closer to the parks, illegal land brokers acquired land from the owners of legal record and developed a considerable portion of these plots in the 1990's. Illegal land brokers were able to develop these plots rapidly, taking

[4] For an excellent description of how this type of development took place in the various neighborhoods in the City of Cochabamba refer to Goldstein (2004) for the case of Villa Sebastian Pagador, and Solares and Bustamante (1986) for the case of Villa Mexico.

advantage of a jurisdiction dispute between national and municipal governments regarding the national parks.[5] This classification is similar to the illegal subdivision but, given that the land had a low option value (due to development restrictions), the perceived threat of eviction for settlers was less than that of illegal subdivisions undertaken in other unprotected parts of the city. Thus, we expect this type of development to experience more significant upgrading after legalization than that of comparable settlements that originated as illegal land sales on non-protected areas or squatter settlements.

Legal settlements include neighborhoods developed in accordance with existing property laws and government regulations at the time of settlement. Legal settlements face no risk of eviction during origination and, as a result, we expect that legal settlements will exhibit greater housing quality than comparable settlements undertaken under greater possessory risk.

Neighborhood characteristics: The empirical models (6) and (7) include location specific attributes expected to influence redevelopment decisions: distance from the central business district (CBD), distance from a major road, block's direction from the CBD (captured in octants; i.e., octant 1 = north-north-east direction), percent of homes connected to the sewer system, and block age.[6] We also include a scale measure of the income level of each block.[7]

[5] The dispute over jurisdiction arose after the passage of Bolivian decentralization laws 1654 and 2028 that changed both geographic boundaries and powers of state and municipal governments but were unclear about jurisdiction over areas designated as national parks.

[6] Block age was obtained using information from Solares (1990) for blocks consolidated between 1574 and 1945, and by direct comparison of census maps for the 1976-1992 and 1992- 2001 periods.

[7] The Bolivian census does not ask for household income per se. The census however collects information about ownership of durable goods such as TV sets, cars, phone lines, etc. We draw on these variables to construct an income scale using factor analysis on the entire sample of city blocks. The appendix gives a complete explanation and details about the construction of the income scale.

Finally, the model includes separate controls for the percent of housing units occupied under monthly lease and under antichresis lease. The antichresis lease is a popular type of lease agreement in Bolivia and other civil law countries.[8] It differs from the monthly rent contract familiar to residents of common law countries. In the antichresis lease, the tenant pays the landlord a large lump sum, generally equal to one third of the property value, when the agreement is signed. The lump sum is returned to the tenant in its entirety at the end of the lease period when the tenant surrenders the property to the owner. Thus, the property rent is covered by the returns on the lump sum during the lease period.

The rental property variable is included in the model to account for possible differences in upgrading and maintenance investments found for owner-occupied properties versus tenant occupied properties under monthly rent contracts (Iwata and Yamaga, 2008; Mayer, 1981; Shilling, Sirmans and Dombrow, 1991; Turnbull and Zahirovic-Herbert, 2010). The antichresis variable is included in the model because the antichresis lease gives the tenant the primary claim on the property that supercedes third party mortgage interests (Navarro and Turnbull, 2010), thereby limiting the usefulness of properties under antichresis leases as loan collateral. In addition, Navarro and Turnbull (2010) show that monthly rent and antichresis lease agreements create different investment incentives for property owners. Taken as a whole, these results suggest that empirical urban development models should include controls for both monthly rent and antichresis leases where they are prevalent.

Model (7) includes the same information as (6) but also the change in the total number of homes, the percentage change in the homes occupied by owner, and the change in the percentage of homes connected to the sewer system in the 1992-2001 periods. Finally, model (7) also

[8] See Navarro and Turnbull (2010) for a detailed description of the antichresis lease, its history in various civil law countries, and its economic implications in terms of tenant and landlord investment incentives.

includes the percentage of college educated individuals and the percentage of homes of high quality in 1992 as a baseline level control in model (7). Table 1 reports the descriptive statistics of all the variables used in the two empirical models.

5. Empirical Results

Table 2 reports the neighborhood housing quality estimates for the fractional probit model (6). Columns 1, 2, and 3, predict the percentage of houses in a city block classified as high, medium and low quality, respectively. The main variables of interest are the neighborhood legal origin and the interaction terms between the legal origin and neighborhood income. Before turning to these variables, we note that the relationships between the other census block characteristics and housing quality reported in table 2 are as expected. The coefficient on the income variable in the three models reflects the effect of rising income on the type of housing quality for city blocks that originated in the formal sector holding other characteristics fixed. The estimates show that, holding other block characteristics constant, rising income increases the percentage of high quality housing and decreases the percentage of medium and low quality housing in blocks that originated in the formal sector.

The coefficients on the legal origin binary indicators in table 2 represent the difference in the percentage of homes falling in a quality category between blocks developed in the formal sector and blocks developed under each particular informal mode holding other variables (including income) constant. The coefficients for the informal settlement categories are generally negative for high quality homes and non-negative for lower quality homes. Thus, comparing city blocks with similar characteristics, blocks that originated as squatter or other informal settlements tend to have fewer high quality houses than blocks that originated in the formal

sector. The marginal effects calculations summarized in table 3 show that, holding other characteristics constant at sample mean levels, the proportion of high quality housing in former squatter settlements (with the greatest possessory risk at the time of settlement) tends to be about 0.21 lower than the proportion of high quality homes in formally originated settlements. Illegal subdivisions (now legal) and informal settlements that occurred with central (but not municipal) government support yield more modest but still significantly lower proportions of high quality homes relative to formally originated settlements of about 0.11 and 0.08, respectively. Illegal subdivisions (still illegal) exhibit significantly greater proportions of medium quality homes than legally settled subdivisions. Only illegal subdivisions in protected areas yield insignificant effects on the mix of housing quality. These relationships are consistent with the predicted title quality legacy effect.

The income-legal origin interaction terms show the differences in the effect of income on city block housing quality between blocks that originated in the formal sector and those that originated in the informal sector. Because the fractional probit specification is non-linear, the interaction effects may not be accurately reflected by the coefficients of the interaction terms reported in table 2 alone (Ai and Northon, 2003). Thus, we present the predicted interaction effects following Ai and Northon (2003) in figures 2-4 (for comparison, table 3 includes the calculated marginal effects using the traditional method). Figures 2, 3, and 4 present the predicted interaction effects of the income indicator and each occupation strategy for the high (6.1), medium (6.2), and low (6.3) quality models respectively. Each plot in a figure shows the statistically significant predicted interaction effect on the vertical axis, and the predicted values

of the dependent variable on the horizontal axis.[9] Blank panels indicate no statistically significant interactive effects.

As figure 2 shows, the interaction effects between income and illegal occupation strategies are negative and statistically significant for settlements that were originally occupied illegally (and are now legal) in the high quality model (6.1). This means that increasing income in a particular city block increases the proportion of high quality homes in settlements that originated illegally at a lower rate than it does for comparable legally settled city blocks. Further, the strongest average interaction effects correspond to squatter settlements, government supported subdivisions and the older illegal subdivisions (now legal), in that order. This is consistent with the theory, since these types of settlement faced higher probabilities of eviction at the time of settlement.

Figures 3 and 4 show the interaction effects of title quality at origin and income for the medium quality model (6.2) and low quality model (6.3), respectively. As the graphs show, majority of the statistically significant predicted interaction effects tend to be positive across different illegal occupation strategies. These results suggest that income increases the proportion of medium and low quality homes in city blocks that originated illegally at a faster rate that it does for comparable blocks that originated in the formal sector. Taken together, the entire set of initial title quality and income interaction results provide evidence of a significant lock-in effect for housing quality in informal sector developments. Even after informal settlements are regularized (legalized), they upgrade more slowly and at lower rates than in comparable settlements originated in the formal sector, with the differences generally rising with income level.

[9] Statistical significance is assessed using Wald tests at the .05 level.

The estimates from the change in housing quality model (7) in table 4 corroborate the fractional probit results. These estimates show that the upgrading trajectories between 1992 and 2001 are distinct across city blocks that originated with different degrees of title quality. Holding income and other factors constant, the average change in the percentage of homes of high quality in a particular city block is lower for city blocks that originated as squatter settlements and illegal subdivisions supported by the government than city blocks that originated in the formal sector. The results reported in table 4 reveal that squatter settlements have an average change in the percentage of high quality homes 11 percentage points lower than comparable city blocks that originated in the formal sector during 1992-2001. Further, the negative coefficient on the interaction term between block income and squatter settlement shows that increasing income levels in a block tend to increase the percentage of high quality homes for blocks in former squatter settlements at a slower pace than it does for blocks developed by the formal sector. The coefficients on the interaction terms between income and settlement type in table 4 are all negative and statistically significant as a group [$F(3,1189) = 3.03$]—which implies that the title quality legacy effect on upgrading increases with income.

The results reported in tables 2-4 reveal a strong effect of title quality at the time a settlement was developed on future redevelopment patterns. Generally, the lower the quality of the title at the origin, the lower the subsequent upgrading rates. These relationships are in line with the explanation offered earlier by the theoretical model.

6. Conclusion

Legalizing informal property titles improves beneficiaries' well-being. Following de Soto's (2000) prescriptions, the preferred policy to improve outcomes for households living in informal

settlements has been to provide them clean ownership titles. Property prices reflect the possessory risk summarized in title quality (Lanjouw and Levy, 2002; Miceli et al., 2002). Empirical evidence from Argentina and Peru supports the notion that formal property rights lead to better housing quality and child education (Galiani and Schargrodsky, 2006), better child health (Galiani and Schargrodsky, 2004), and greater labor supply (Field, 2003). There is, however, little evidence that title formalization policies stimulate improvements in housing quality. Studies of Argentina and Peru show no strong positive relationship between formal title provision and greater access to bank loans; housing upgrades undertaken by recipients of title formalization tend to be modest and financed from household resources rather than loans that could have underwritten more significant improvements (Calderon, 2003; Galiani and Schargrodsky, 2006). The lack of a clear link between title provision and upgrading has been labeled a mystery by observers. The fact that titling programs have been in place for more than two decades in many parts of the world further exacerbates this empirical mystery.

This paper presented a theoretical explanation to part of this puzzle and offered supporting empirical evidence from Bolivia. Drawing from current literature on squatter settlements and urban development, our model predicts that possessory risk in the form of a perceived threat of eviction during an illegal settlement's origination has significant legacy effects on future neighborhood upgrading. Squatters or other participants in informal land market transactions invest more heavily in the initial (low quality) structure to the extent it reduces the risk of eviction. At the same time, though, greater structural density increases the cost of future improvements, which in turn reduces the incentive to subsequently improve housing quality even after legal title is awarded.

Our empirical study of Cochabamba, Bolivia, provides additional evidence supporting this prediction of the theoretical model. Stratifying different neighborhoods by their differing degrees of title risk, we find different housing quality characteristics for otherwise identical neighborhoods occupied by owners with legal title. The mix of housing units by quality varies with the original title quality and underlying eviction risks when the areas were originally settled; the proportion of high quality units rises with the degree of title security at the time of settlement. In addition, income tends to have a lower marginal effect on housing quality in illegal settlements than it does in comparable legal settlements. In summary, while title formalization long after settlement origination may eliminate vestiges of the initial possessory risk, it does not appear to remove the legacy effect of the initial development pattern on subsequent redevelopment.

These results help to explain the persistence of low housing quality and the low rates of neighborhood upgrading in former squatter settlements even long after regularization. This paper presents a plausible explanation of why titling programs need not necessarily lead to property upgrading, a finding that has puzzled many observers of urban policy in developing countries. While the underlying economic forces identified here might not provide a complete answer to the puzzle, our evidence implies that they are an important component.

Appendix

Construction of the housing quality variable.

For the purpose of this paper, housing quality refers exclusively to construction materials employed in the housing structure. Construction materials are classified into low, medium or high quality using the Bolivian National Institute of Statistics (INE) shown in table A.1. The next step is to construct a set of housing quality variables that reflected the percentage of houses in a city block in the high, medium, or low classification according to the construction materials employed in the housing structure. We classify houses with high quality materials in at least 2 parts of their structure as high quality houses. Similarly, houses with low quality materials in at least 1 part of their structure are classified as low quality houses. Finally, all houses in neither the high nor low quality categories are classified as medium quality houses. The same methodology and material quality classification is used for both 1992 and 2001 censuses to construct our dependent variable.

Construction of the income variable.

Bolivia's last population census (2001) did not ask respondents to provide their level of income. The survey, however, includes a series of questions concerning ownership of household equipment and appliances, among others. We use exploratory and confirmatory factor analysis on a group of these indicators to construct an income index at the census block level.

The variables used to construct the index using a principal component extraction method of factor analysis were: percent of households in the block that own a TV set; percent of households in the block that own a car; percent of households in the block that own a refrigerator at home;

and percent of households in the block that own a telephone line. Table A.2 reports the correlation matrix for these variables.

Our principal component analysis of these variables produces a set of factors of which the first explains about 75% of the variance in the 4 variables combined (Eigen value = 2.98). The second factor explains only 14% of the variance in the 4 variables combined (Eigen value =.58). Using the Kaiser-Guttman rule we conclude that these 4 variables produce only 1 principal component (i.e., block income) with a reasonable degree of reliability. The Cronbach alpha coefficient for these 4 variables is 0.88. We also apply Confirmatory Factor Analysis to test the one-factor model. The results give ample support for the one-factor model: Model $\chi^2 = 12.96$ (df =1); Root Mean Square Error of Approximation (RMSEA) = 0.04; 90% confidence interval for the RMSEA = (0.024; 0.066); and Comparative Fit Index (CFI) = 0.99. Table A.3 reports the estimated Eigen values for each component. The block income variable in the empirical analysis is constructed using the estimated Eigen vectors (factor loadings) shown in table A.4.

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Table 1. Descriptive Statistics

Block Legal Origin	**City Blocks (n)**	**Percent**	**Cumulative**
Illegal subdivision (protected area)	334	5.06	5.06
Squatter settlement	304	4.61	9.67
Government supported settlement	221	3.35	13.01
Illegal subdivision (still illegal)	581	8.8	21.81
Illegal subdivision (now legal)	818	12.39	34.21
Legal	4,343	65.79	100
Consolidation Time Period	**City Blocks (n)**	**Percent**	**Cumulative**
1574-1812	74	1.12	1.12
1812-1900	91	1.38	2.5
1900-1945	584	8.85	11.35
1945-1976	2,171	32.89	44.24
1976-1992	2,656	40.24	84.47
1992-2001	1,025	15.53	100
Block direction from CBD (Octant)	**City Blocks (n)**	**Percent**	**Cumulative**
1. N-NE	611	9.26	9.26
2. NE-E	533	8.07	17.33
3. E-SE	228	3.45	20.78
4. SE-S	1,987	30.1	50.89
5. S-SW	802	12.15	63.04
6. SW-W	431	6.53	69.57
7. W-NW	727	11.01	80.58
8. NW-N	1,282	19.42	100
Block characteristics in 2001	**City Blocks (n)**	**Mean[a]**	**Std. Dev.[a]**
Distance from the CBD (km)	6601	4.47	2.23
Distance to a major road (km)	6601	.86	1.26
% Homes connected to sewer system	5880	52.65	45.14
% Homes occupied by owner	5880	54.31	21.6
% Homes under antichresis lease	5880	8.81	10.5
% Homes under monthly rent lease	5880	23.59	17.56
Income (Factor—see appendix)	5787	0	2.03
% of High Quality homes	5880	40.65	32.22
% of Medium Quality homes	5880	56.87	31.19
% of Low Quality homes	5880	2.5	8.4
Change in Block characteristics 1992 -2001 (sample)	**City Blocks (n)**	**Mean[a]**	**Std. Dev.[a]**
Change in % of high quality homes 92-01	1258	7.93	18.61
Change in % homes with sewer system 92-01	1258	34.47	36.42
Change in % owner occupied homes 92-01	1258	-2.83	22.19
Change in the number of homes 92-01	1258	5.25	9.99
Block characteristics in 1992 (sample)	**City Blocks (n)**	**Mean[a]**	**Std. Dev.[a]**
% homes of high quality in 1992	1258	30.46	31.9
% individuals with college degree in 1992	1258	2.07	4.09
Note: (a) Means and standard deviations calculated using the number of city blocks observed for each variable.			

Table 2. Housing Quality Models - Fractional Probit Specification

Model	(6.1)	(6.2)	(6.3)
Dependent variable	Proportion of High Q homes	Proportion of Medium Q homes	Proportion of Low Q homes
Income (factor)	0.283	-0.252	-0.231
	[0.011]***	[0.010]***	[0.021]***
Illegal subdivision (protected area)	-0.061	0.08	-0.012
	[0.072]	[0.071]	[0.135]
Squatter (invasion)	-0.642	0.644	0.223
	[0.083]***	[0.077]***	[0.100]**
Government supported settlement	-0.244	0.246	0.185
	[0.059]***	[0.057]***	[0.083]**
Illegal subdivision (still illegal)	-0.108	0.178	0.142
	[0.085]	[0.083]**	[0.113]
Illegal subdivision (now legal)	-0.29	0.446	-0.582
	[0.055]***	[0.055]***	[0.128]***
Illegal subdivision (protected area) * Income	-0.016	0.055	0.01
	[0.041]	[0.037]	[0.062]
Squatter * Income	-0.196	0.246	0.053
	[0.060]***	[0.050]***	[0.060]
Government supported settlment * Income	-0.185	0.179	0.117
	[0.081]**	[0.075]**	[0.064]*
Illegal Subdivision (still illegal) * Income	-0.018	0.151	-0.041
	[0.040]	[0.038]***	[0.052]
Illegal Subdivision (now legal) * Income	-0.136	0.227	-0.195
	[0.028]***	[0.030]***	[0.062]***
% Homes connected to sewer system	0.002	-0.002	-0.004
	[0.000]***	[0.011]***	[0.001]***
Distance from the CBD (km)	-0.025	0.034	0.046
	[0.012]**	[0.016]***	[0.021]**
Distance to a major road (km)	-0.052	0.062	0.064
	[0.017]***	[0.000]***	[0.028]**
% homes under antichresis	0.000	0.001	-0.007
	[0.001]	[0.001]	[0.002]***
% homes under rent	-0.002	0.004	-0.007
	[0.001]***	[0.001]***	[0.001]***
Constant	0.391	-0.581	-1.895
	[0.088]***	[0.086]***	[0.253]***
Observations	5794	5794	5794

Notes: Coefficients are Probit estimates. Robust standard errors in brackets. Coefficients on direction (octants) and time of consolidation variables not reported here.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Fractional Probit Estimates (Marginal Effects)

Model	(6.1)	(6.2)	(6.3)
Dependent variable	Proportion of High Q homes	Proportion of Medium Q homes	Proportion of Low Q homes
Legal Origin Binary Indicators **			
Illegal subdivision (protected area)	-0.019	0.025	0
Squatter	-0.207	0.219	0.012
Government supported settlement	-0.084	0.088	0.007
Illegal subdivision (still illegal)	-0.033	0.06	0.006
Illegal subdivision (now legal)	-0.105	0.164	-0.01
Legal Origin-Income Interaction terms*			
Illegal subdivision (protected area) * Income	-0.001	0.019	0
Squatter * Income	-0.045	0.066	0.005
Government supp settlement * Income	-0.063	0.065	0.006
Illegal subdivision (still illegal) * Income	0.003	0.055	-0.001
Illegal subdivision (now legal) * Income	-0.043	0.074	-0.002

*Each of the coefficients is evaluated at mean levels and holding other binary variables at 0

** Measures effect of a discrete change from 0 to 1

*** Measures marginal effect dy/dx

Table 4. Change in the percentage of high quality homes 1992-2001, OLS estimates

Model	(7)
Dependent Variable	Change in % of high quality homes 1992-2001
Squatters	-11.642
	[2.416]***
Gov supported settlement	-4.703
	[1.815]***
Illegal subdivision (now legal)	-2.907
	[2.110]
Block income in 2001	7.149
	[0.711]***
Block income in 2001* Squatters	-4.202
	[1.472]***
Block income in 2001* Gov. supported settlment	-0.421
	[1.551]
Block income in 2001*Illegal subdivision	-1.944
	[1.427]
Change in % homes with sewer system 92-01	0.004
	[0.015]
Change in % owner occupied homes 92-01	-0.047
	[0.028]
Change in the number of homes 92-01	-0.021
	[0.075]
% homes of high quality in 1992	-0.586
	[0.032]***
% individuals with college degree in 1992	0.255
	[0.189]
Distance to a major road (Km)	-0.002
	[0.001]***
Distance from CBD (Km)	-0.002
	[0.002]
Constant	33.519
	[3.344]***
Number of observations (City Blocks)	1211
R-squared	0.43

Notes: Robust standard errors in brackets. Coefficients on direction (octants) and time of consolidation variables not reported here.

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Table A.1. Classification of Housing Construction Quality by Main Materials Used in Walls, Roof and Floors

Quality	Wall Materials	Roof Materials	Floor Materials
High	Bricks, Cement, Concrete	Tiles (cement, clay fiber-cement)	Treated wood Carpets Tile, ceramic
Medium	Rock Adobe (covered)	Zinc plates	Brick Cement
Low	Adobe (not covered) Cane, Palma Other	Palma, Cane, Dirt Other	Dirt Other

Table A.2. Correlation matrix of variables used to construct block income index

	TV pct	Car pct	Refrig pct	Phone pct
TV pct	1.00			
Car pct	0.45	1.00		
Refrig pct	0.69	0.67	1.00	
Phone pct	0.59	0.73	0.84	1.00

Table A.3. Estimated Eigen values using principal component extraction method on 4 census indicators of household income

Component	Eigenvalue	Difference	Proportion	Cumulative
Component 1	2.98	2.40	0.74	0.74
Component 2	0.58	0.29	0.15	0.89
Component 3	0.29	0.14	0.07	0.96
Component 4	0.15	.	0.04	1.00

Table A.4 Factor loadings used to estimate block income variable

Variable	Component 1
TV pct	0.45
Car pct	0.47
Refrig pct	0.54
Phone pct	0.53

Figure 1: Illegal settlements typology for the city of Cochabamba (2001)

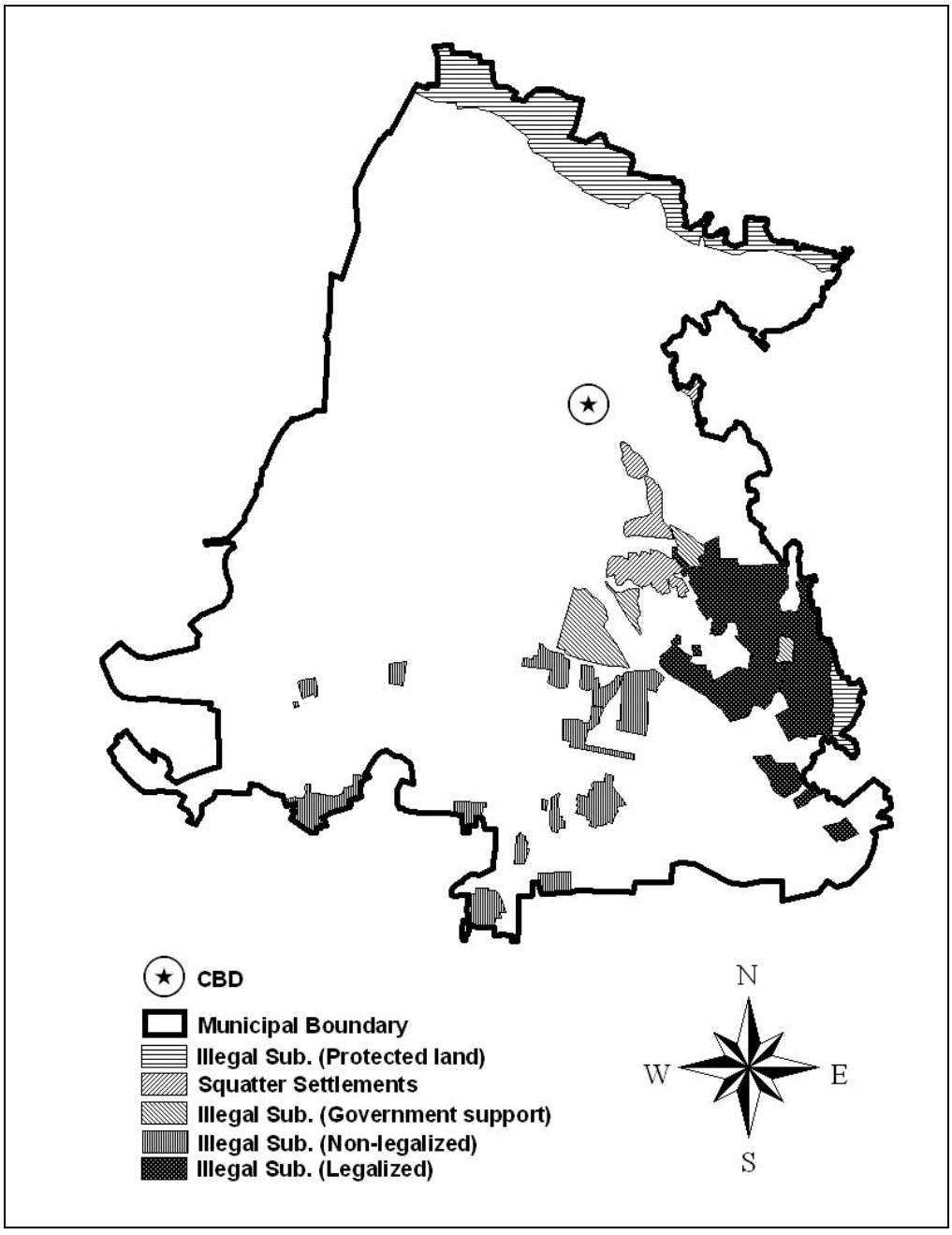

Figure 2: Interaction effects – Occupation strategy*Income - for model 6.1

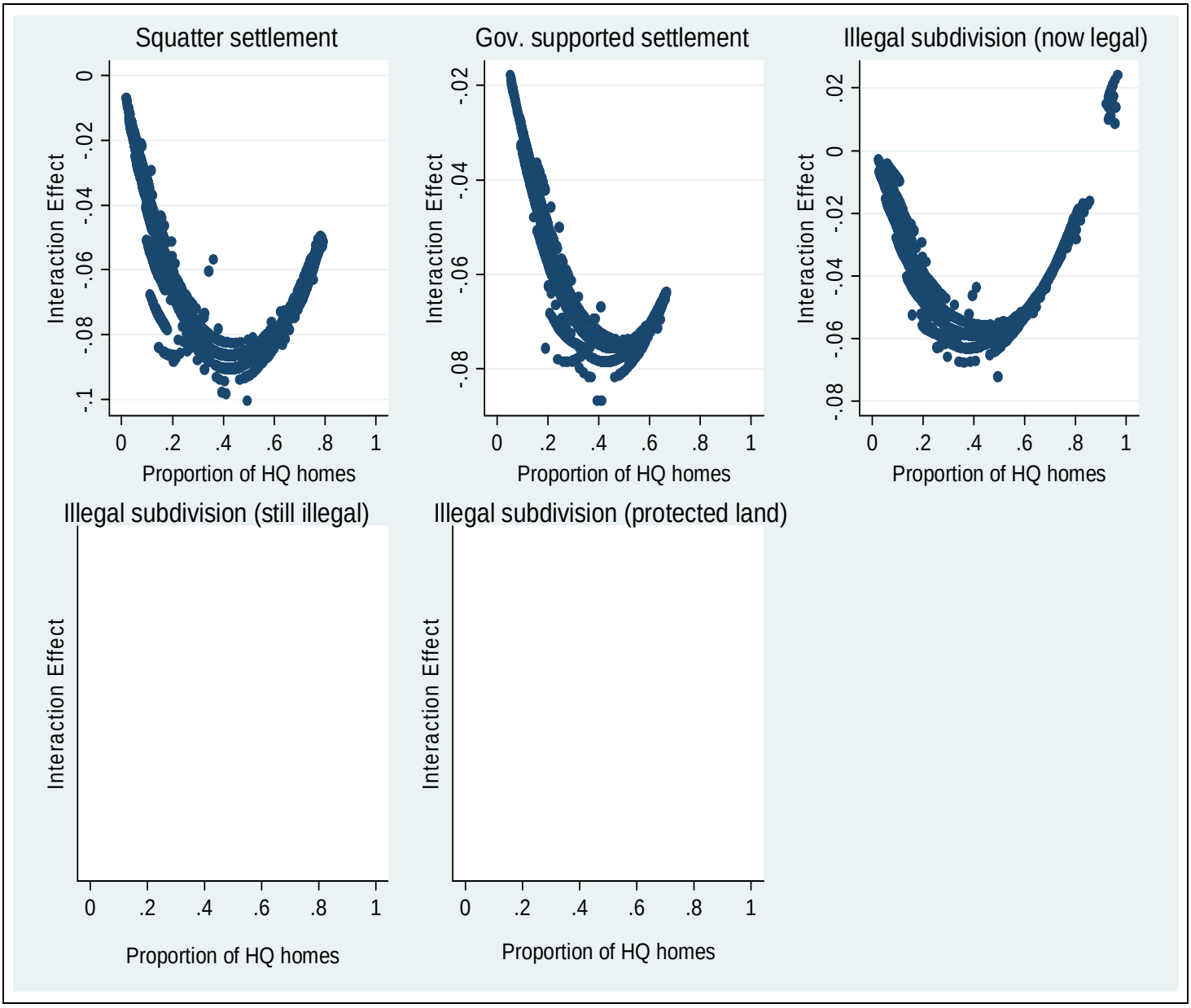

Figure 3: Interaction effects – Occupation strategy*Income - for model 6.2

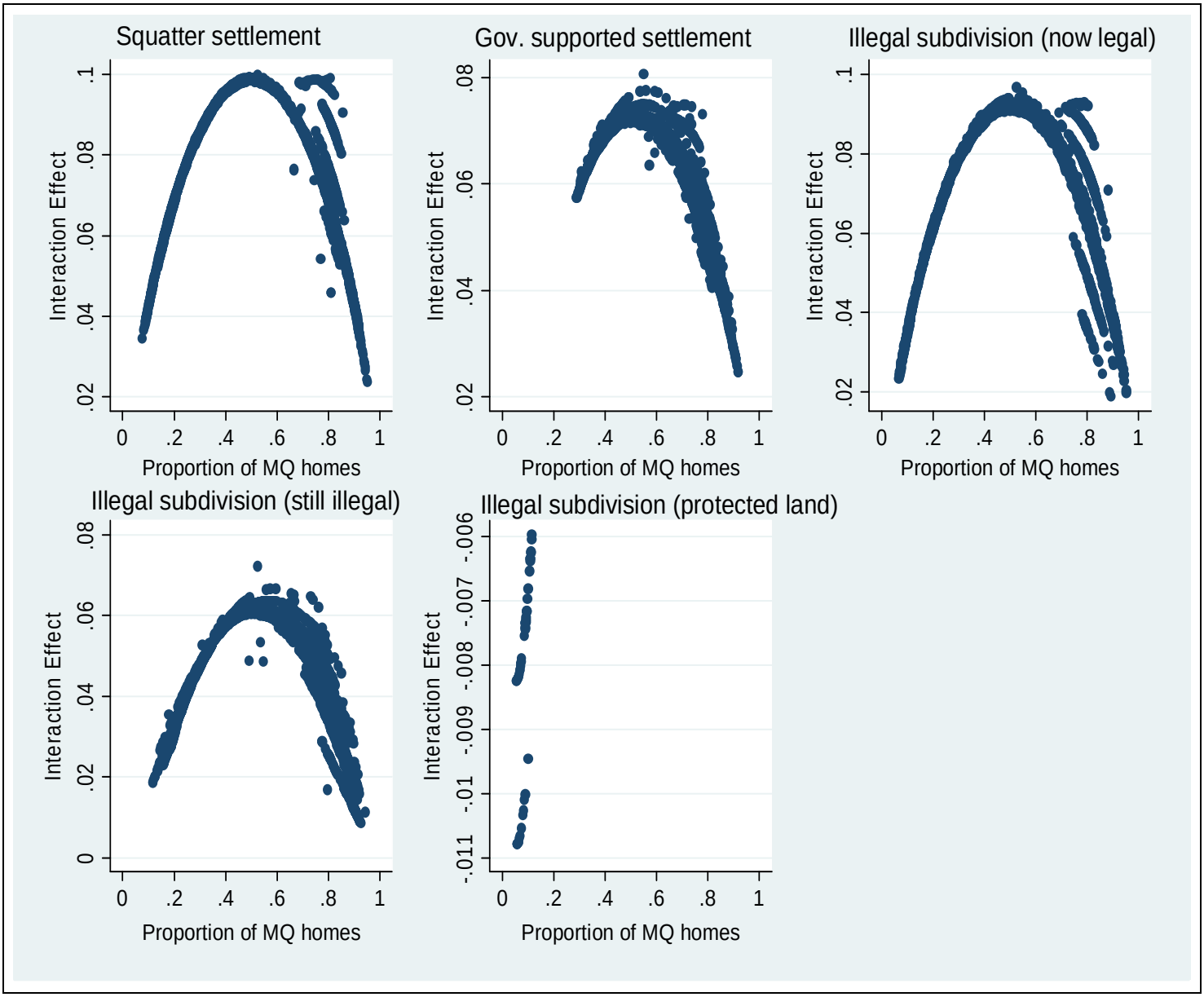

Figure 4: Interaction effects – Occupation strategy*Income - for model 6.3