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HECTOR NUÑEZ; DUSAN PAREDES & RAFAEL GARDUÑO-RIVERA

# Is crime in Mexico a disamenity? Evidence from a hedonic valuation approach




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## *Abstract*

*Since Roback (1982)'s seminal work, the literature has evaluated the role of the amenities to equilibrate the regional differentials of nominal wages and prices. While these studies generally find evidence for traditional amenities and disamenities in developed countries, it still exists a scarce exploration on how those characteristics assessed, like violence, affect the equilibrium in less developed countries. In this paper, we explore violence as amenity or disamenity for the case of Mexico as a particular and unique natural experiment. We use the hedonic wage and rent theory proposed by Roback using data from the Mexican Household Income and Expenditure Survey, along with other information at municipal and state level. For our particular hypothesis, we find evidence to support that inhabitants in traditional drug trafficking states could consider drug-related crime as an amenity.*

**Keywords: Hedonic Valuation, Wages, Rents, Amenities, Crime, Mexico**
**JEL codes: D5; H4; J3; Q2; R1; R2**

## *Resumen*

*Desde el trabajo seminal de Roback (1982), la literatura ha evaluado el papel de las amenidades para equilibrar las diferencias regionales de salarios y precios nominales. Si bien estos estudios generalmente encuentran evidencia para amenidades y desamenidades tradicionales en los países desarrollados, todavía existe una escasa exploración sobre cómo esas características evaluadas, como la violencia, afectan el equilibrio en países menos desarrollados. En este trabajo, se explora la violencia como amenidad o desamenidad para el caso de México, el cual por sí es un experimento particular y único. En este trabajo seguimos la teoría de precios hedónicos de salarios y rentas propuesta por Roback, y usamos los datos de la Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH), junto con otra información a nivel municipal y estatal. Respecto a nuestra principal hipótesis, encontramos evidencia que en estados caracterizados por un alto tráfico de drogas se podrían considerar los delitos relacionados a las drogas como una amenidad.*

**Palabras clave: Valoración hedónica, salarios, rentas, amenidades, crimen, México**
**Codigos JEL: R11 y R15**

## *Introduction*

While the literature has widely identified the significant role of the amenities to explain the spatial differentials of wages and rents, yet there is lack of empirical analysis to measure the economic valuation of other type of existing amenities in less developed countries. As Vásquez, Dresdner, and Aguilar (2011) point out, this shortage is due to the lack of information on crucial amenities such as air quality, congestion indicators and insecurity, especially detailed spatial scale at country level. We argue that it is not only a problem related to information availability, but also to the social and economic reality of these countries, which requires a different conceptualization about what can be interpreted.

For most developed countries, disamenities like crime and insecurity are considered a serious disincentive on local housing prices and wages (e.g. Roback 1982; Roback 1988; Berger, Blomquist, and Sabirianova Peter 2008; Aslam and Corrado 2011). Although the empirical applications fit very well into these countries because people are willing to avoid dense, unsecure or polluted regions for a cleaner, safe and sparse areas; it appears not be enough to explain the case of less developed countries where population concentrate in dense areas like capital cities even if other cities can offer an apparently lower cost of life (Krugman 1999). Using this particular context, we raise the questions: how this economic valuation would change if these disamenities were interpreted as economic opportunities to increase wages? For example, weighting the risk of being caught, could the local inhabitants see an illegal activity as an amenity? This potential interpretation not only opens new research questions in the case of less developed countries, but it also requires empirical challenges to test the explicit hypothesis of illegal activities considered as amenities.

We explore our hypothesis for the case of Mexico as a particular and unique natural experiment due to several reasons. First, the literature has widely highlighted the alarming high levels of crime mainly associated with drugs trafficking (e.g. Pan, Widner, and Enomoto 2012; Rios 2008). Second, the illegal drugs market deals with high profits that could make to some citizens directly and indirectly better off (Reuter and Kleiman 1986). Third, the drugs trafficking in Mexico follows a clear spatial pattern where main clusters are consistently located in the north side of the country (Vilalta 2013). These facts open a space to test our hypothesis about the potential differentiation of Marginal Willingness to Pay (MWTP) between north and the rest of Mexico. In particular, we expect that crime or insecurity conditions are valued as disamenities in those states where illegal drugs' trafficking is not seen as a regular economic activity. Contrasting, we expect that the economic benefits derived from illegal activities lead crime to be seen as an amenity. Fourth, we want to use a within country context to exploit the similar and homogeneous institutional background with similar legal rules and mechanism design. This point is central to identify a causal mechanism because different institutional rules could design a different mechanism

design among countries and, consequently, our empirical strategy could not capture this event.

We use the hedonic wage and rent theory proposed by Roback (1982) to compute the MWTP for crime and other amenities in Mexico. In the estimation process we propose a simultaneous determination of wages and rents to estimate the shadow prices for each amenity including, of course, crime rates. Once we estimate the MWTP at state level for crime rate, we use spatial exploratory analysis to test if the spatial pattern of MWTP answers to a significant non-random pattern and to build confidence intervals of MWTP to test if our estimations are significant across all the country.

Using data from the Mexican Household Income and Expenditure Survey (ENIGH), along with other information available at municipal and state level from INEGI´s Population and Economic Censuses (and Surveys), our results show that amenities do reduce the differential in income across regions. For our particular hypothesis, we find evidence that inhabitants in traditional drug-trafficking states, like Sinaloa and Baja California (in the Northwest), could consider crime as an amenity. With regards to other amenities, we find evidence that higher pollution affect negatively income and rents, while climate conditions affect them positively.

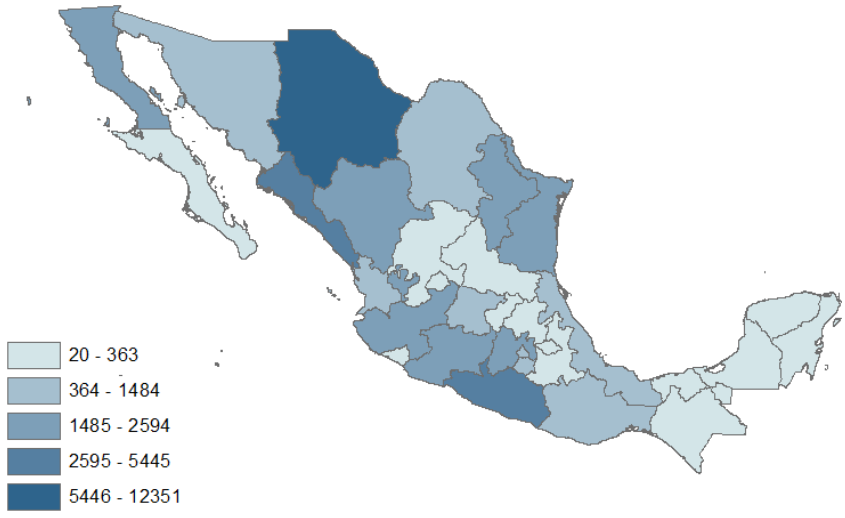
## *Economic Perspective of Crime in Mexico*

In the last decades, Mexico has increased dramatically its crime rate, especially in Metropolitan Areas and near the U.S. border, due to its increased participation in drug trafficking rings (Vilalta 2013). During Calderon´s presidency (2006-2012), one of the main objectives was to decrease the crime rate cause mainly by criminal organizations, undertaking drug trafficking, extortions and kidnappings. However, the crime rate still growing until our days (The Economist 2014). Sharing a border with one of the largest per capita drug-consumption country (the United States) has made an increase in the production and smuggle of drugs to supply such demand, since most of the U.S. imports of drugs comes from Mexico (Reuter and Kleiman 1986; Fajnzylber, Lederman, and Loayza 2000). Mexico tops the list in production of marijuana, opium (potentially heroin) and amphetamine, which is also reflected in the seized quantities reported by the United Nations where Mexico occupies a place within the top ten countries in the world (UNODC 2012).

Figure 1 shows the spatial distribution of the drug trafficking related murders, where the states that border the Pacific Ocean and those that border the United States present a higher number of deaths (Arias and Esquivel 2012; Márquez-Padilla, Pérez-Arce, and Rodríguez-Castelán 2015). Most of the drug-related homicides in 2011 occurred in Chihuahua (29%), Sinaloa (12%), and Tamaulipas, Guerrero and Durango (21% all three together) (Enamorado et al. 2014). In here, we observe that the connection provided by the Pacific Ocean among the Asian countries, Colombia and

Mexico makes the Mexican western states an ideal destination or the landing of different drugs in Mexico, and, therefore, the starting point for the distribution within Mexico and the United States (UNODC 2014).

**FIGURE 1: DRUG TRAFFICKING RELATED HOMICIDES (2006-2011)**




Source: (Consejo de Seguridad Nacional (CSN) 2013) and authors' calculation.

Even though, there is a large literature that analyzes the multiple social and quality of life consequences of drug related crime (such as Baker 2008; Fajnzylber, Lederman, and Loayza 2000; Ousey and Lee 2002; Vilalta 2013; among others), little has been studied about the economic consequences cause by drug related crime. Still , drug-related-crime has affected the economic stability of many places, since companies decide to close down and move to securer places (Ramírez, Gómez, and Muñiz 2015). Foreign Direct Investments (FDIs) decide to redirect their investment to other places (and countries) (Madrazo-Rojas 2009). Likewise entrepreneurs run their businesses from afar, displacing their families to safer cities or overseas, to avoid kidnapping (Enamorado et al. 2014). Nevertheless, little has been done to study the economic consequences; especially in developing countries like Mexico.

Only a few number of studies try to understand the effect of drug-related-violence on economic growth and labor force participation. Enamorado, López-Calva and Rodriguez-Castelán (2014) do a cross-municipal analysis in Mexico and find that drug-related crime deters economic growth. In the same way, Detotto and Otranto (2010) do a state level panel data from 1979 to 2002 and also find that organized crime strongly affect the economic performance for the case of Italy. Whereas Arias and

Esquivel (2012) do a panel analysis of the 32 states with data from 2006 to 2010 and find that drug-related homicides increase unemployment[1] . Similarly, Robles, Calderón, and Magaloni (2013) find that drug-related crime deters labor force participation.

In the case of Mexico, it is necessary to understand how drug-related crime had affected regional economy, especially in the wages and rent prices, to know how citizens and companies react to this offence. In some Mexican states, where drug cartels started and have been active ever since, it seems that their society has been able to live with it and continue developing their economy: creating jobs and reactivating their economy. Thus, drug-related-crime appears to be the *modus vivendi* of an economy that can live with drug-trafficking and continue their economic growth (Márquez-Padilla, Pérez-Arce, and Rodríguez-Castelán 2015) . It appears that, despite the increase crime in those states, they have taken crime as an amenity. But an amenity in the way that does not reduced their economic performance, more over it increases its investment in some cases. It occurs particularly in Mexican states closer to the U.S. border. Those that have benefited from their proximity to the U.S. market producing (and exporting) all sort of agriculture and manufacturing goods and have been the top economic regions in Mexico during the last 40 years.

However, there are no studies analyzing whether drug-related-crime has an effect on a regional economy, especially on wages and rent prices. The study of this effect, especially in developing countries like Mexico, will allow us to understand if drug-related crime can perform as an amenity for a regional economy, increasing their performance. That is why this paper examines whether or not drug-related crime has an effect on the regional economic activity (especially on rent prices and wages), and if this effect exists, has it been as an amenity or disamenity across the country.

## *Hedonic model*

The formal model used here follows Roback's (1982) model and a similar notation to that in Bayer, Keohane, and Timmins (2009). In this paper we work with household information (microdata) identified at municipality level including capital cities and 16 boroughs (*delegaciones*) for the case of D.F. This model assumes $N$ homogeneous individuals who choose their location k and maximize utility $U^k$. $U$ is a function of a composite good $x$, a housing good $h$ and a set of location amenities $S_k$ such as air quality and violence. In equation (1) individuals maximize $U^k$ subject to a budget restriction.

[1] They find the effect is disproportionately higher in women than in men. And that this effect increases self-employment.

$$\max_{x,h,S} U^k(x, h; S_k)$$

Subject to

$$x + \rho_k h = w_k \tag{1}$$

Where the price of $x$ is used as numeraire, $\rho_k$ is the price of housing and $w_k$ is the wage at location *k*. When solving (1) we get the demands as function of the price vector $[1, \rho_k]$ and income $w_k$ and substituting them back into the utility function, it results in the indirect utility function, $V^k$, as shown in equation (2).

$$V^k = V(w_k, \rho_k; S_k) \tag{2}$$

Taking the total derivative of (2), using Roy´s Identity given that we know that - $\frac{V_\rho}{V_w} = h$ (the Marshallian demand for housing), and solving for $\frac{V_S}{V_w}$, we obtain equation (3).

$$\frac{V_S}{V_w} = h\frac{d\rho}{dS} - \frac{dw}{dS} \tag{3}$$

Where $V_j$ denotes the partial derivative with respect to the variable *j*: $w, \rho, S$. The right hand side of equation (3) is equal to $p^*$ or the Marginal Willingness to Pay (MWTP) for the amenity. To simplify the analysis, we divide both sides of equation (3) by *w* and divide and multiply the first term of the RHS by $\rho_k$:

$$\frac{p^*}{w} = h\frac{\rho_k}{w}\frac{d\rho}{dS}\frac{1}{\rho_k} - \frac{dw}{dS}\frac{1}{w} \tag{4}$$

Alternatively as in equation (5),

$$\frac{p^*}{w} = \theta\frac{dln\rho}{dS} - \frac{dlnw}{dS} \tag{5}$$

Where $\theta$ is the share of rent in the consumer budget.

Note how this simple model would predict that those cities with negative amenities, such as pollution level, should increase the wage level in order to maintain a similar utility level. However, our hypothesis can work the other way around: such disamenities would increase people's wages; therefore, people would prefer to stay in their cities.

### *Empirical estimation strategy*

As we will describe in the following section, our data set includes observations for almost 138 thousand household observations throughout 18 years and 604 municipalities in the 32 Mexican states. To calculate the MWTP in equation (5), we need to obtain estimations for $\frac{dln\rho}{dS}$ and $\frac{dlnw}{dS}$, that is, estimation for the individual wage and rent as a function of the amenities $S_k$ and other characteristics $D_k$ at location *k*. Since wage (*w*) and rent ($\rho$) can be a simultaneous decisions, we make both variables function of each other, but in the case of rent, we make it a function of total household income (*HI*) instead of the individual *i*. To isolate the effect of the amenities and other characteristics of the location, we make also income a function of the individual characteristics (*X*) and rents of house characteristics (*C*). In addition, since we cannot observe the individual spatial real income at every location *k*, we control income and rents by a state index price (*P*). Finally, we include a set of dummies to control by time (*YR*) and spatial effects (*ST*), in the latter case we can only include state dummies due to the dataset limitations. The resulting equations are displayed in (6) and (7).

$$\ln w_{i,k,t} = \beta_0 + \delta_t YR_t + \delta_k ST_k + \beta_1 \ln \rho_{h,k,t} + \beta_2 X_{i,k,t} + \beta_3 \ln P_{k,t} + \beta_4 S_{k,t} + \beta_5 D_{k,t} + \upsilon_{i,k,t} \quad (6)$$

$$\ln \rho_{h,k,t} = \delta_0 + \gamma_t YR_t + \gamma_k ST_k + \delta_1 \ln HI_{h,k,t} + \delta_2 C_{h,k,t} + \delta_3 \ln P_{k,t} + \delta_4 S_{k,t} + \delta_5 D_{k,t} + \nu_{h,k,t} \quad (7)$$

Where *h* subscribes household, *k* subscribes location, and *t* time. The terms $\upsilon_{i,k,t}$ and $\nu_{h,k,t}$ denote vector of errors.

To estimate equations (6) and (7), we start using a linear Ordinary Least Square (OLS) estimation. Since we are interesting in the coefficient of crime rate, we allow this variable to interact with a dummy variable at state level. We also include square

terms for age, population, temperature and precipitation to better capture their marginal effects. However, some inefficient can exists also for the joint nature of the problem since people may take both decisions (wage and rent) simultaneously, and will cause correlation among households in the error terms of both equations. Hence we also estimate (6) and (7) using a Seemiling Unrelated simultaneous Regression (SUR) model.

### *Data and Variables Description*

We gather information from different sources and build a data set for every two years (from 1994 to 2012) for households located in 604 municipalities, including the largest cities from each state and Mexico City (D.F.), which is subdivided in 16 *delegaciones* that are distinguished in the sample. A short description of the variables, summary statistics and sources are reported in table 1. After organizing the data set, we end up with 138,738 observations. The primary source for this study is the Mexican Household's Income and Expenditures National Survey (ENIGH by its name in Spanish, *Encuesta Nacional de Ingresos y Gastos de los Hogares*) reported by the INEGI (2012) (National Institute of Statistics and Geography or INEGI by its name in Spanish, *Instituto Nacional de Estadística y Geografía*), which is applied every two years and consistently available since 1994. The ENIGH contains individual and household characteristics such as age, education, sex, household rooms and availability of electricity, water and phone line. As dependent variable in equation (6), we use the natural logarithm of the quarterly income reported by household´s head as the dependent variable, and in equation (7), we use the natural logarithm of quarterly rent reported or imputed.[2]

This paper aims mainly to estimate the effect of violence in rent and income, so we use crime rate as its proxy variable. Crime rate per 100 thousand inhabitants by municipality (*crime rate*) was collected from SIMBAD system of INEGI (2012b). Figures in table 1 show an average of 13 crimes across the entire sample, although it is a high number, the standard deviation is even larger (about 20), what indicates the large dispersion of crime in Mexico.

The ENIGH does not report commuting time, which is one important variable for this sort of studies because it also represents a potential negative externality. To fill this gap, we use the *Usage Time National Survey* (ENUT) from INEGI (2009) for the years 2002 and 2009 to construct an average commuting time used by surveyed to commute to and from work for each of the 608 municipalities. The air quality information is gathered from the National Emissions Inventory for Mexico (INEM) reported by the Instituto Nacional de Ecología y Cambio Climatico (2005) for the years 1999 and 2005 at State level. The Inventory comprises the following air pollutants: Carbon Monoxide (CO), Sulfur Dioxide ($SO_2$), Nitrogen dioxide ($NO_2$),

[2] When housing is not rented, INEGI asked "how much would you pay if you were renting the house?"

Volatile Organic Compounds (VOC), Particulates Matter (PM10 and PM2.5) and Ammonia ($NH_3$). To take advantage of the household data, the information from 1999 is used for the period 1992-2000 and that from 2005 for the period 2002-2012. To avoid some noise caused by including all these pollutants in the regression, we use instead the first principal component (PCA) of all seven pollutants (air pollution in table 1).

Other local amenities include living in the capital city where people may accept a reduction in real wages as long as they access to the economics of agglomeration derived from this city. We also consider road distance to the U.S. border (*distance*) as an important amenity for the Mexican case, since Mexico is the only Latin American country with a border to the largest world economy (the United States). Distance acts as amenity, related to the transportation cost of the new accessible U.S. market, attracting labor to work near the border (Baylis, Garduño-Rivera, and Piras 2012). Population (*pop*) and population square are important to control for other amenities scale (INEGI 2009b).

In order to incorporate the effect of other economic characteristics at regional level, we also include state unemployment rate reported by INEGI´s (2012c) *Occupation and Employment National Survey* (ENOE). Finally, we need to include climate conditions as another important amenity for the model. Seasons are not really strong marked in Mexico; however, it is different to live close to the sea (Atlantic or Pacific) or at a high altitude. Aiming to control for these factors but keeping the model parsimonious enough, we have included the municipality´s average temperature and its square as well as the precipitations and precipitations square. We also include a variable for cooling degree days (*cdd*), which is calculated for temperatures above 18 degrees Celsius, to represent the effect of places where high temperatures predominates. The climate variables are gathered from the National Weather Service (SMN) of CONAGUA (2012).

## *Results and Discussion*

In this section we show results by the two methodologies, namely OLS and SUR. Model estimates for the log of wage and rent (equation 6 and 7) are reported in table 2. Along with the regression coefficients, we also report the coefficient of determination.

In the wage equation (columns 1 and 3 of table 2), the coefficients for human capital (*sex*, *age*, and *educ*) are positive and significant without significant differences between both models. The *rent* coefficient is also positive and significant, and results in a rent-wage elasticity of 36%. In the case of the rent equations, the house characteristics (*kitchen, bathroom, water, electricity, phone line, bedrooms, h_size*) are positive and significant as well as household income (*l_HI)*, which results in a wage rent

elasticity of 50%. All these coefficients do not change significantly across models. These results are in line with the vast literature of wage hedonic theory and housing hedonic prices. A higher human capital is, in average, correlated with higher wages as well as gender gap is also manifested by the positive coefficient associated to male workers. A similar interpretation for the case of housing applies and better structural characteristics are positively correlated with higher price. The most interesting result in this first round of estimations is the positive elasticity obtained for both equations which implies that our suspicious on the simultaneous determination are supported by these initial estimations. Both elasticities are significant and they reveal that any hedonic approach should make an effort to deal with this issue.

In regards to the economic and other characteristics of the locations: the price index (*ln_p*) shows a positive and significant coefficient in the OLS under the wage equation, while not significant under SUR model. For the case of rent, the coefficient for both models is positive and significant as expected. This result is related to the simultaneity of the problem: although both decisions wage and rent could be taken at the same time, local prices are not a relevant variable to determine the wage willing to accept for living in a determined location. Unemployment rate coefficient (*unemployment*) in the wage equation is negative and significant; so, the higher the rate, the lower the wage. Whereas in the rent equation under both models the sign is positive and significant. Basically, it means that cities with high unemployment will repeal people to places with lower unemployment rate and lower rents. The population coefficient (*pop*) is significant and positive in the OLS wage equation, while its square (no reported) is negative and significant, meaning a positive (the more population the higher wages and rents) marginally decreasing relationship, which is a good representation of the Latin American capitals. For simplification, we do not report constant, dummy and interaction coefficients, but they are available from the authors upon request.

Being in a place near the U.S. border (*distance* coefficient) does not affect wages. Although its results are significant in the rent equation under both models, its effect is really small. The coefficient for commuting time (bottom panel of Table 2) is negative and significant under the rent equation, which makes sense that people would pay lower rents the further they live. It is worth notice that the expected sign for commuting time is not clear due to both high and low income families may live far from their jobs, especially in largest cities.

Looking at the climate variables (*Temp*, *Precipitation*, *CDD*), only precipitation and CDD are positive and significant in the rent equation. That is, people should pay higher rents (marginally decreasing) in cooling and rainy cities. With respect to air pollution, its coefficient (PCA of CO, NO_2, VOC, PM10, PM2.5, NH3, SO_2) is significant and negative in the rent equation and positive and significant in the wage equation under both methodologies. Hence, it seems that air pollutants helps to achieve the

equilibrium in the labor market in Mexico because people would get higher income and pay lower rents in places highly polluted.

Finally the main variable of interest, crime rate, reports a negative coefficient but only significant under the wage equation in OLS. It is important to notice that table 2 does not report the total effect of the amenities, but only the coefficient of crime rate; without considering the square terms and interactions. So we now turn to calculate the price of each amenity and characteristic in the following section, which illustrates better the total effects, in particular that of crime rate.

To calculate the price of the effects as in equation (5), we need the average budget share of rent ($\theta$) and the average quarterly wage ($w$) for México whose values are 24% and MXN$20,918, respectively. In the case of crime rate, we use these parameter calculated at state level. Prices with negative signs should represent disamenities, while positive characterize amenities. Standard errors were obtained using 100 bootstrapping simulations. Results for prices and standard errors are reported in table 3.

First, both models OLS and SUR are consistent reporting the same sign except by *population*, *distance* and *commuting time*; however, *commuting time* is not significant in both models, and *distance* is only significant under SUR. Thus, *population* results are the only inconsistent characteristic. Since SUR model solves one problem that OLS does not, we rely better on the sign of the former model, which is population as an amenity. When strictly looking at the amenities, *precipitation* and *CDD* result in net amenities, while air pollution and temperature result in net disamenities. The interpretation of air pollution price is, for instance, that people would be willing to pay either MXN$1,057 (OLS) or MXN$1,712 (SUR) quarterly for a cleaner air.

With regards to the amenity of interest, i.e. crime rate, taking advantage of the interaction with the state effects, we prefer to illustrate its effect in the maps in figures 4 and 5, which show only the statistically significant prices for each state. Figure 4 shows the cases when crime rate can be seen as an amenity, where the states in common under OLS and SUR are the northwest states (i.e. Baja California, Sonora, Sinaloa, Jalisco and Colima).

One possible explanation for this positive sign is that some of the traditional drug cartels belong to these states that historically have reported high crime rates from 10 per 100 thousand inhabitants every year in Jalisco to 34 per 100 thousand inhabitants every year in Sinaloa during the last 20 years. Thus, people see the illegal activities in their regions including their negative consequences as the economic opportunities to increase wages that cannot be achieved in other region.

On the other hand, crime rate results in a net disamenity, as expected, in Nuevo Leon, where the third largest city of México is located (Monterrey) and also it exists a

drug cartel, but it is one of the main financial centers of the country, and people can get higher incomes from other sources. For the case of Veracruz and Campeche, both of these states are strongly related to the oil industry. In Chiapas and Guerrero, which are the less developed states of Mexico (see figure 5), even illegal activities are not seen as an opportunity to increase wages.

Aiming to illustrate the weight that amenities achieve as a measure of regional quality of life, we use the prices reported in table 3 and figures 4 and 5 as weights of the average value of the amenity or characteristic in each state. This results in a Quality of Life Index (QOLI) for each state, as suggested by Roback (1982). To illustrate better the results we report the Index in the map in figure 6. The Northwester states, except by Sinaloa, report the highest QOLI mainly due to the low population density and the favorable weather conditions. Whereas the central-pacific states, like Guerrero, Michoacán, Morelos and DF result with the lowest QOLI mainly due to the high crime rate.

## *Conclutions*

High wages and rents in Latin American countries are usually found at the largest cities, where local people would not consider moving to a far state, but would prefer to stay or live nearby. Additionally, people from the provinces still keep moving to those large cities, without realizing that the quality of life may not be that high. In this paper, we use a hedonic valuation model to assess the case of Mexico whose capital, Mexico City (D.F.) is one of the largest cities in the world and apparently characterized by having the highest wages and housing rents in the country. We have found that most Mexican municipalities not only compensates but overcomes the wage differential respect to the D.F. when we consider the cost of life and the amenities that those cities can offer. The previous result can be supported by our second finding; most cities offers lower housing rents than the D.F. no matter the people´s income or the regional amenities.

Regarding the amenities, we find that insecurity and air pollution affects negatively salaries, and to help achieving the equilibrium in the labor market in Mexico, people would get higher income in safer and cleaner places. However, crime results in an amenity in some states, but not as such but in the way that does not reduced their economic performance. Finally, climate conditions are relevant factors for rents but not for wages. That is, people located at warmer and rainy cities should pay higher rents, but where temperatures are significantly above the national average, rents should decrease.

The results presented in this analysis have important policy implications for local governments to develop local amenities because they will bring higher salaries and likely higher rents, but will incentive local people to stay in their cities and do not move to the largest cities.

# *Appendix*

**TABLE 1. SUMMARY STATISTICS**

| Variable | Description | Source | Time | Mean | Standard Deviation |
|---|---|---|---|---|---|
| | *Dependent variables* | | | | |
| ln_w_h | Log household head quarterly income | ENIGH | 1994-2012 | 9.05 | 1.12 |
| ln_rent | Log house rent in 2012 Mexican Pesos | ENIGH | 1994-2012 | 7.68 | 1.03 |
| | *Individual (Household Head)* | | | | |
| Age | Age of Household head in years | ENIGH | 1994-2012 | 46.55 | 15.22 |
| Sex | Dummy (1 if male, 0 otherwise) | ENIGH | 1994-2012 | 0.79 | 0.41 |
| Educ | Dummy (kindergarden=1; incomplete primary=2; complete primary=3; incomplete secundary=4; complete secundary=5; incomplete high school=6;complete high school=7; incomplete bachelor=8; complete bachelor=9; incomplete postgraduate studies=10; complete postgraduate studies=11) | ENIGH | 1994-2012 | 5.086 | 2.647 |
| | *Household level* | | | | |
| ln_HI | Log total household income | ENIGH | 1994-2012 | 9.82 | 0.95 |
| Bedrooms | Number of rooms destined to sleep | ENIGH | 1994-2012 | 1.98 | 0.93 |
| Kitchen | Dummy (1 if Kitchen available, 0 otherwise) | ENIGH | 1994-2012 | 0.91 | 0.28 |
| Water | Dummy (1 if piped water available, 0 otherwise) | ENIGH | 1994-2012 | 0.89 | 0.31 |
| Phone line | Dummy (1 if land phoneline available, 0 otherwise) | ENIGH | 1994-2012 | 0.41 | 0.49 |
| Electricity | Dummy (1 if electricity available, 0 otherwise) | ENIGH | 1994-2012 | 0.98 | 0.15 |
| Bathroom | Dummy(1 if W.C. available, 0 otherwise) | ENIGH | 1994-2012 | 0.92 | 0.27 |
| h_size | Number of people living in the house | ENIGH | 1994-2012 | 4.09 | 2.06 |

**MUNICIPALITY LEVEL**

| | | | | | |
|---|---|---|---|---|---|
| Capital | Dummy (1 if capital city, 0 otherwise) | | N/A | 0.24 | 0.43 |
| Crime Rate | Homicides per 100 thousand population | SIMBAD | 1994-2010 | 13.15 | 19.95 |
| Distance | Distance in km to the nearest US Border crossing point | SCT | N/A | 984.72 | 505.60 |
| Pop | Number of Inhabitants | CNPyV | 1990, 1995, 2000, 2005 & 2010 | 413,741 | 441,772 |
| Commuting Time | Average weekly minutes of commuting from/to work | ENUT | 2002 & 2009 | 290.87 | 76.61 |
| CDD | Cooling degree days: (max temp - min temp)/2 - 18 | | 1994-2012 | 25.00 | 68.27 |
| Temp | Average daily temperature (°C) | CONAGUA | 1994-2012 | 15.97 | 5.02 |
| Precipitation | Average daily precipitation (mm) | CONAGUA | 1994-2012 | 2.50 | 1.86 |
| | *State level* | | | | |
| Air pollution | PCA of CO NO2 VOC PM10 PM2.5 NH3 SO2 | | 1999 & 2005 | 0.005 | 2.352 |
| ln_p | State Consumer Price Index | INEGI | 1994-2012 | -0.42 | 0.44 |
| Unemployment | Unemployment rate (%) | ENOE | 1997-2012 | 3.94 | 1.82 |

**TABLE 2. WAGE & RENT EQUATIONS (DEPENDENTS VARIABLES: LOG OF HOUSEHOLD HEAD' QUARTERLY WAGE AND HOUSEHOLD QUARTERLY RENT)**

| | Wage | Rent | Wage | Rent |
|---|---|---|---|---|
| | OLS | | SUR | |
| *Individual (Household Head)* | | | | |
| ln_rent | 0.368*** | | 0.639*** | |
| Sex | 0.310*** | | 0.321*** | |
| Age | 0.063*** | | 0.017*** | |
| Educ | 0.131*** | | 0.100*** | |
| *Household level* | | | | |
| ln_HI | | 0.509*** | | 0.620*** |
| Kitchen | | 0.188*** | | 0.159*** |
| Bathroom | | 0.210*** | | 0.178*** |
| Water | | 0.165*** | | 0.138*** |
| Electricity | | 0.109*** | | 0.095*** |
| Phone line | | 0.252*** | | 0.219*** |
| Bedrooms | | 0.136*** | | 0.105*** |
| h_size | | -0.074*** | | -0.080*** |
| *Other Characteristics* | | | | |
| ln_p | 0.440*** | 0.486*** | -9.968e-02 | 0.521*** |
| Unemployment | -0.007** | 0.009*** | -0.010*** | 0.011*** |
| Capital | -0.045*** | 0.062*** | -0.063*** | 0.062*** |
| Distance | -0.000 | -0.000*** | 0.000 | --0.000*** |
| Pop | 0.231*** | 0.724*** | -0.152*** | 0.610*** |
| *Amenities* | | | | |
| Crime Rate | -0.025*** | -0.003 | -0.009 | -0.005 |
| Commuting Time | -0.000 | -0.000*** | 0.000 | -0.000** |
| Air pollution | 0.038*** | -0.088*** | 0.062*** | -0.073*** |
| Temperature | -0.011** | 0.002 | -0.009** | 0.000 |
| Precipitation | -0.018*** | 0.006*** | -0.009*** | 0.008*** |
| CDD | -0.000* | 0.000*** | -0.000*** | 0.000*** |
| State effects | Yes | Yes | Yes | Yes |
| Time effects | Yes | Yes | Yes | Yes |
| N | 138445 | 138445 | 138445 | 138445 |
| $R^2$ | 0.54 | 0.70 | 0.52 | 0.70 |

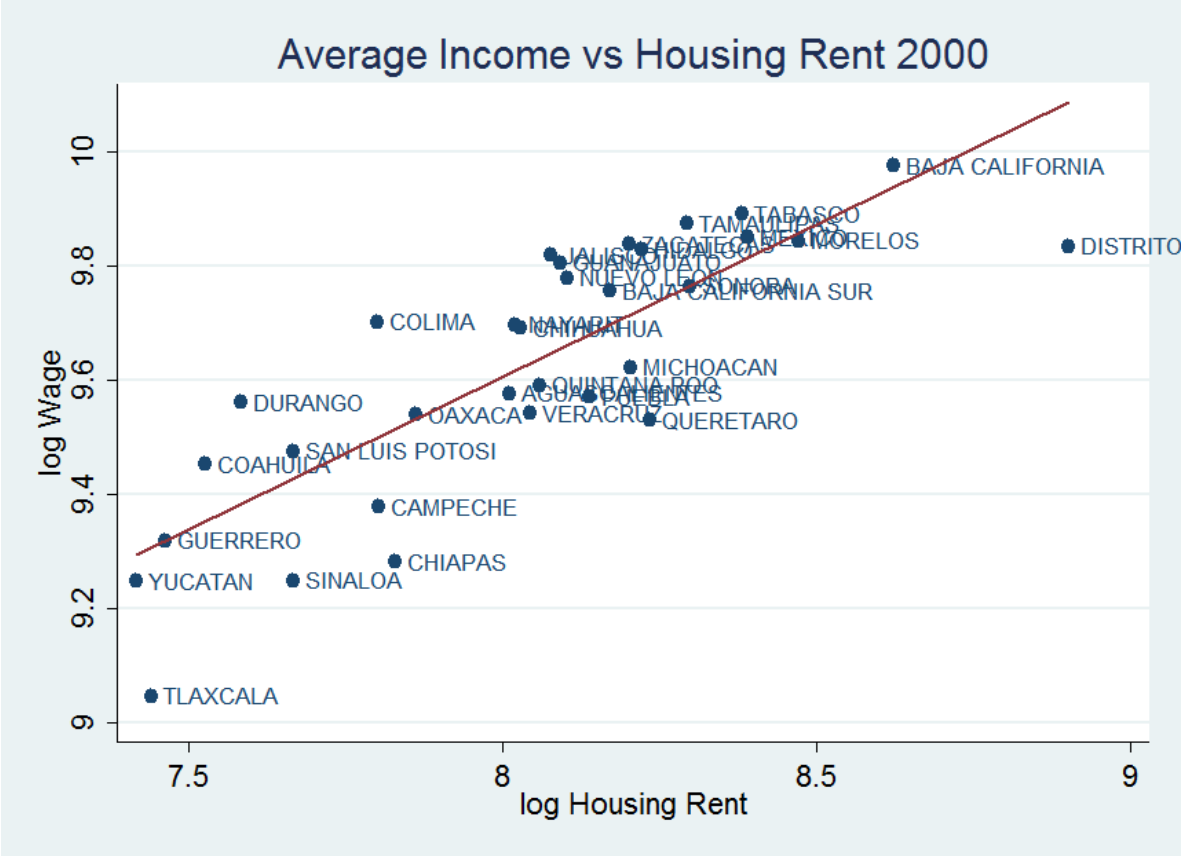
*Significant level at 10% **5% ***1%.

**TABLE 3. AMENITIES PRICES**

| | Price | Std* | Price | Std* |
|---|---|---|---|---|
| | OLS | | SUR | |
| *Other Characteristics* | | | | |
| Unemployment | 138.3 | (71.5) | 224.3 | (69.74) |
| Capital | 1,293.5 | (147.97) | 1,758.8 | (150.03) |
| Distance | 0.0 | (2.97) | -0.9 | (2.45) |
| Pop | -427.8 | (247.38) | 3,927.9 | (249.8) |
| *Amenities* | | | | |
| Commuting Time | 1.3 | (2.97) | -1.6 | (2.45) |
| Air pollution | -1,057.3 | (170.03) | -1,712.5 | (151.57) |
| Temp | -85.9 | (23.45) | -118.7 | (22.64) |
| Precipitation | 275.2 | (44.68) | 246.1 | (48.4) |
| CDD | 2.7 | (0.80) | 3.3 | (0.86) |

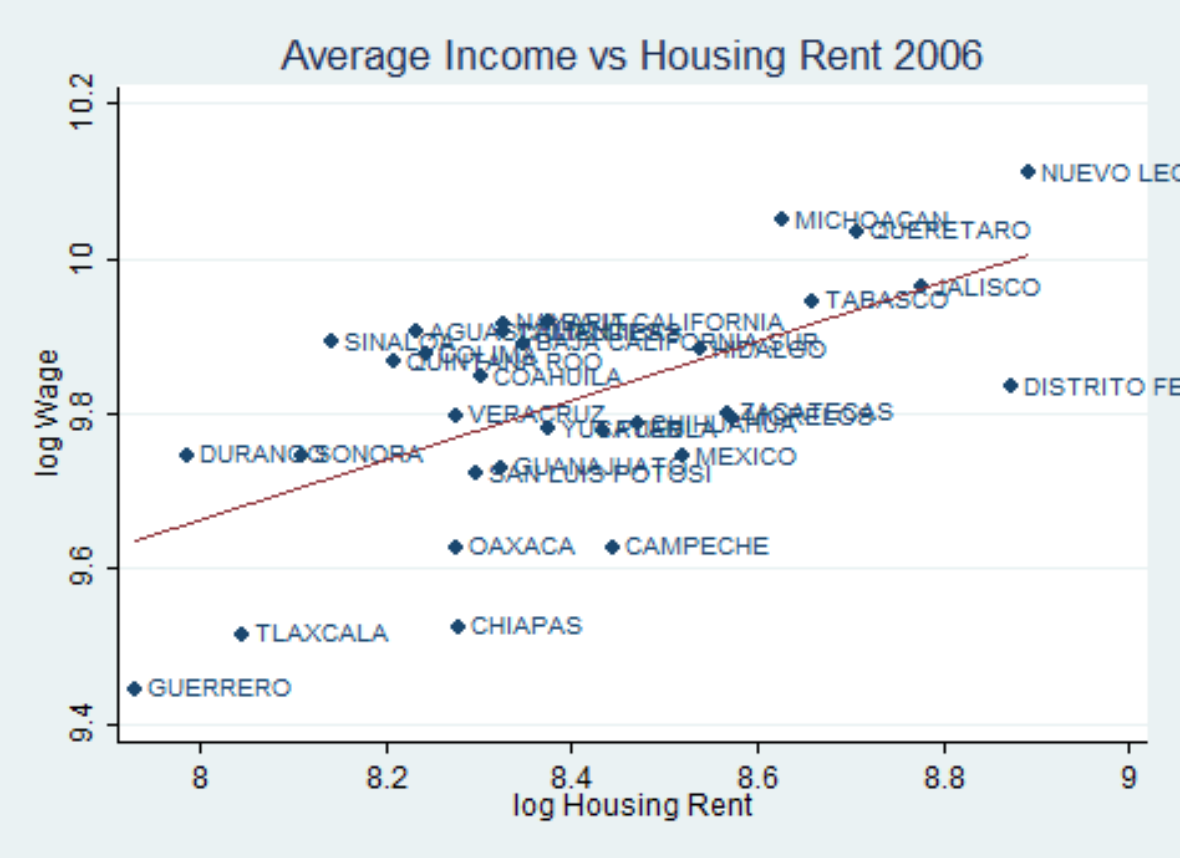
Standard error in () parenthesis

**FGURE 2. RENT VS. INCOME, 2000, MEXICO**




Source: ENIGH (INEGI 2012a)

**FIGURE 3. RENT VS. INCOME, 2006, MEXICO**




Source: ENIGH (INEGI 2012a)

**FIGURE 4. PRICE OF CRIME RATE AS NET AMENITY**

**(A) OLS**


(b) SUR

**FIGURE 5. PRICE OF CRIME RATE AS NET DISAMENITY**

**(A) OLS**


(b) SUR

**FIGURE 6. QUALITY OF LIVE INDEX (QOLI) FOR MEXICO**

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