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# The effects of bodyweight on wages in urban Mexico

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## Les effets de la corpulence sur les salaires dans les zones urbaines mexicaines


### Résumé

*Les effets de la corpulence sur les salaires seraient étroitement liés au niveau de développement. Alors qu'au sein des pays riches, les obèses tendent à être pénalisés sur le marché du travail, les plus corpulents y sont généralement avantagés dans les sociétés les moins avancées. Cependant, pour beaucoup d'économies émergentes comme le Mexique, la nature de la relation reste encore inconnue. Compte tenu d'une situation nutritionnelle intermédiaire où coexistent la malnutrition et l'obésité, la littérature suppose que la relation serait plutôt quadratique dans ces pays. En utilisant des données de panel provenant de l'enquête Mexican Family Life Survey, l'objectif principal de ce chapitre consiste alors à analyser les effets de la corpulence sur les salaires au sein des zones urbaines mexicaines. Pour ce faire, nous mettons en œuvre une procédure économétrique en deux étapes, basée sur une fonction de gain de type Mincer, qui permet de s'affranchir simultanément du biais de sélection de l'échantillon et des potentiels problèmes d'endogénéité. Pour identifier la nature exacte de la relation, nous complétons les estimations paramétriques avec une analyse semi-paramétrique vérifiant graphiquement la robustesse des résultats. Contrairement aux hypothèses formulées, l'effet de la corpulence sur les salaires suivrait plutôt une relation linéaire au Mexique, avec des distinctions selon le type de contrat et le genre. Pour les salariés disposant d'un contrat formel, l'IMC tend à avoir un effet négatif et significatif sur les salaires, en particulier pour les femmes. Toutefois, on observe une relation causale positive mais non-significative entre la corpulence et les salaires des salariés ayant un contrat informel. Notons que ce résultat surprenant concernerait particulièrement les femmes. Cependant, il convient de préciser que la difficulté à bien identifier la fonction de gain de ces emplois informels pourrait surévaluer cet effet positif.*


**Mots-clés :** Mexique ; pays émergents ; salaires ; type de contrat ; corpulence ; obésité.

## The effects of bodyweight on wages in urban Mexico


### Abstract

*The effects of bodyweight on wages seem to be closely linked to the level of development of the country concerned. In rich countries, overweight and obese workers seem usually penalized, whereas in the poorest societies the fattest tend to earn more. However, in several emerging economies such as Mexico, the nature of the effect is complex and remains still unknown. Given a complex nutritional situation where hunger and obesity coexist, the literature suggests a quadratic relationship in these countries. The main objective of this study is to explore the impact of bodyweight on wages in urban Mexico using panel data from the Mexican Family Life Survey. Two main methodological treatments are highlighted. First, we implement a two-stage model, based on an expanded Mincer earning function, to control for potential sample selection bias and endogeneity problems. Second, we use complementary parametric and semi-parametric estimators in order to analyze accurately the nature of the relationship. Our results show that the effects of bodyweight on wages in Mexico depend on the kind of contract and gender. For employees with formal contracts, BMI tends to have a negative and linear impact on wages, especially for women. By contrast, we find a positive but non-significant causal relationship between bodyweight and wages for employees with informal contracts. Note that this surprising result could concern women particularly. However, the difficulty in well identifying the earning function of such informal employments is likely to overstate this positive effect.*


**Keywords:** Mexico; emerging countries; wage; kind of contract; bodyweight; obesity.

**JEL:** O150; O170; O120; I130; J310; J71

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## 1. INTRODUCTION

Since the number of individuals who are overweight and obese is increasing constantly around the world and reaching endemic levels in some countries (Egypt, Mexico, the United States, South Africa, etc.), a growing number of researchers are becoming interested in the impact of these nutritional changes on employment outputs. It is well known that bodyweight may affect employment and wages through the level of productivity (presenteeism and absenteeism) as well as social discrimination by the employer and/or customers. Nevertheless, the existing literature suggests that sociocultural beliefs related to weight perception are particularly important insofar as the effects depend on the level of a country's development. For instance, several authors note that the causal relationship between bodyweight and wages is generally negative in rich economies, especially for women, despite differences between ethnicity and work status (Cawley 2004; Sarlio-Lahteenkorva, Silventoinen and Lahelma 2004; Brunello and D'Hombres 2007; Johar and Katayama 2012). These findings could be explained by the Western perception of bodyweight. In these countries, obese people are generally perceived as lazy, slow, unattractive and lacking in rigor (Runge 2007). By contrast, in the poorest societies, fat people are usually considered as the most attractive because high bodyweight symbolizes health, strength, wealth and prosperity (Renzaho 2004). Therefore, overweight and obesity are not particularly associated with wage penalties, and, in some activities and sociocultural context, bodyweight would tend to improve wages and employment status, especially for men. This is, for example, the case in sub-Saharan African countries such as Guinea, Ivory Coast, Ghana and Ethiopia (Glick and Sahn 1998; Kedir 2008; Schultz 2003).

However, the relationship does not appear to be so clear-cut in emerging economies because of their complex nutritional situation. Given the coexistence of hunger and excess weight in these countries, Shimokawa (2008) assumes a quadratic causal relationship between bodyweight and wages. According to his results, the hypothesis appears to be valid in the Chinese context seeing that underweight and obese workers were the lowest paid. More recently, analyzing the impact of bodyweight on employment in China, Pan, Qin and Liu (2013) observe the same quadratic relationship. Also, findings from these authors reveal an interesting contrast according to work status. Underweight and overweight Chinese were more likely to work in informal activities, finding access to formal employment more difficult. In other emerging countries, results seem also highly related to the kind of employment. For instance, Dinda et al. (2006) show that being overweight was associated with higher wages for Indian coalminers, whereas findings from the Philippines suggest that overweight self-employed women earned significantly less than their slimmer counterparts (Colchero and Bishai 2012).

Despite the absence of research into this topic in the Mexican context, the previous literature highlights two labor market specificities from emerging countries. First, the effects of bodyweight on wages can depend on gender. In addition to strong income inequalities related to gender in Mexico, women have a lesser role in the workplace. The majority are inactive and unpaid family workers (Gong, van Soest and Villagomez 2004). Second, the labor market is split between the formal and informal spheres in developing countries such as Mexico. The formal sphere implies the application of labor laws, social welfare and taxes (with an explicit contract between employers and workers), whereas the informal sphere includes small activities (generally paid less than formal jobs) exercised as part of microbusinesses that are not subject to such regulations (Gong et al. 2004).

Therefore, our main objective is to study the effects of anthropometric status on wages and to determine the nature of the relationship according to gender and the contractual specificities of the Mexican workplace. The analysis uses panel data from the *Mexican Family Life Survey* (MxFLS), which provides three survey waves (2002, 2006 and 2012), and focuses on adults who work as employees. Controlling for potentially sample selection bias and endogeneity problems, we complete standard parametric regressions with semiparametric partially linear regressions in order to perform a visual check of the relationship and test the robustness of the model. The general framework of the model takes the form of an expanded Mincer earning function.
The rest of the paper is organized as follows: Section 2 establishes the methods, Section 3 presents the results, and Section 4 concludes and discusses the main findings.

## 2. METHODS

### 2.1. Data and sample

Data used in this study come from the *Mexican Family Life Survey* (MxFLS), the first survey with a representative sample of the Mexican population at national, rural-urban and regional levels. Sampling directives were drawn up by the Mexican institute of statistics, geography and computing. The survey covers a 10-year period with three distinct waves. The first wave was carried out in 2002 with 35,677 individuals surveyed in 8,440 households (living in 150 municipalities across 16 Mexican states). Given the longitudinal dimension of the survey, the second (2005–2006) and the third (2009-2012) waves are based on the initial sample from 2002. For both waves, the follow-up rate of the initial sample exceeds 90% at household level. MxFLS data include detailed information on socioeconomic characteristics of households and individuals. Moreover, anthropometric data were collected for all household members directly in the home by trained staff from the Mexican institute of public health. Weight was measured with a set of digital scales (accuracy of 0.1 kg) and height with a stadiometer (accuracy of 0.5 cm).

Our sample is restricted in order to comply with the objective of the study. First, we focus exclusively on urban communities (more than 2,500 inhabitants) where obesity problems are particularly developed (Smith and Goldman 2007). Second, pregnant and lactating women were withdrawn from the sample in order to limit anthropometric bias. Third, in line with the labor economics literature, we analyze only the working-age population from 16 to 64 years old (Gong et al. 2004).

The MxFLS reports six work statuses in Mexican cities: (i) inactive people; (ii) unpaid workers; (iii) workers with oral contracts (called informal employees); (iv) workers with written contracts (called formal employees); (v) self-employed workers; (vi) employers. Since the goal is to analyze the effects of bodyweight on wages, the study is restricted to workers receiving a wage, such as employees with formal and informal contracts. By definition, inactive people and unpaid workers do not earn any work income, and, self-employed workers and employers are paid through profits but do not receive salaries.

Finally, given the socioeconomic importance ascribed to gender and the regulation of employment in Mexico, we distinguish male and female, as well as formal and informal employees according to their contract type (written or verbal).

## 2.2. An expanded Mincer earning function

Insofar as the study is based on wage determinants, the general framework of the model takes an expanded form of the Mincer earning function (Mincer 1974). Therefore, the structural wage equation (1) of the parametric analysis takes the following linear form:

$$Y_{it} = \beta X_{it} + \delta B_{it} + \varepsilon_{it} \quad (1)$$

Where $Y_{it}$ is the hourly wage of an individual *i* at the period *t*. We measure the hourly wage variable using the individual income during a regular month and the number of working hours during a regular week[1]. The hourly wage is expressed in pesos using the year 2002 and the Center-South region as the baseline, and, log-transformed. Finally, we fix reasonable wage limits in order to exclude extreme values. Only individuals with a log-hourlywage between 0 and 8 are analyzed.

Then, $X_{it}$ refers to schooling, experience and county variables that structure the earning function. First, inspired by the approach of Mulatu and Schooler (2002), several individual determinants of wages are included as control variables: age, the square of the age (proxy of experience), gender, psychosocial distress, years of schooling. The state of psychosocial distress is a variable built from the sum of 20 questions that provide a diagnosis of the level of stress and depression (Calderón-Narváez 2013). For each question, we attribute the value 1 if the individual feels the malaise expressed and 0 otherwise. Second, as suggested by Baum and Ford (2004), we add variables that control for county differences: presence of high school and hospital in the municipality, region (south or north) and the community size (small, medium or large).

Finally, anthropometric data ($B_{it}$) are added to the set of regressors in order to assess the impact of bodyweight on hourly wages. The individual bodyweight is measured using the Body-Mass Index (BMI). [2] We exclude extreme anthropometric values from the sample. Hence, individuals who have a BMI lower than 15 kg/m$^2$ and higher than 45 kg/m$^2$ are dropped. [3]

## 2.3. Methodological issues

The main methodological issue consists in treating potential sample selection bias due to the focus on employees and the endogenous relationship between bodyweight and hourly wages. To correct both problems simultaneously, we use a two-stage model that combines selection and instrumental variables (IV) regressions. Formulated by Mroz (1987), this model has been frequently used by labor economists (e.g. Renders, Gaeremynck, and Sercu 2010), but also by health and development economists in order to estimate the effect of bodyweight on wages (e.g. Shimokawa 2008).

### *2.3.1. Dealing with sample selection bias*

In our sample, while approximately 55% of women and 16% of men do not participate in the paid

[1] Hourly wage $= \frac{\text{monthly wage}}{\frac{\text{weekly working hours}}{7} \times 30{,}5}$.

[2] According to the World Health Organization (WHO 2000), an individual is underweight when his BMI is lower than 18.5kg/m$^2$, normal-weight when his BMI is between 18.5 and 25 kg/m$^2$, overweight when his BMI is between 25 and 30 kg/m$^2$ and obese when his BMI is higher than 30 kg/m$^2$.

[3] The model has also been tested using the waist-to-height ratio and the waist circumference that better identify central adiposity and health problems than the BMI. Nevertheless, results were similar every time (available from the authors on request). Consequently, we focused exclusively on the BMI in order to facilitate international comparisons and to reduce the number of tables.

labor market, about 36% are employed in formal and informal enterprises. The non-random selection of this subsample might indeed lead to erroneous results insofar as various factors explain why an individual works as an employee or not (marital status, cognitive skills, etc.). A procedure implemented by Heckman (1979) provides a way of correcting for non-randomly selected samples. Hence, we run a discrete choice model (i.e. logistic estimator) that estimates the probability of working as an employee (the base group takes the value 0 if the individual is inactive, an unpaid worker, self-employed or an employer)[4]. We instrument this probability with several indicators inspired by the literature (Trogdon et al. 2008; Johar and Katayama 2012): marital status (in a couple or not), cognitive skills' score (measured using the mental test described by Raven 2000), the square of the cognitive skill's score (assuming a quadratic relationship), whether the individual did a short professional training, the age of the youngest individual in the household and the presence of manufacturing industry (i.e. *maquiladoras*) in the municipality. Then, the correctional term – called the Inverse Mills Ratio (IMR) – is calculated and introduced in the second-stage regressions where the strategies for controlling endogeneity problems are employed.

### *2.3.2. Correcting for endogeneity problems*

Another methodological challenge comes from the endogenous relationship between bodyweight and wages (Cawley 2004). First, the error component might contain non-observable characteristics that explain anthropometric and economic status simultaneously, for instance certain genetic and environmental factors of individuals (mental and physical abilities, behaviors, preferences, etc.). Second, this relationship is potentially affected by the presence of reverse causality. Indeed, weight might influence wages but it is well known that income, and more generally socioeconomic status, determines anthropometric health (Levasseur 2015). Different strategies for correcting these endogeneity problems have been implemented in the health economics literature. At the beginning, researchers used to run ordinary least square (OLS) regressions explaining current wages by lagged measures of bodyweight (Sargent and Blanchflower 1994). Even if this approach allowed the reverse correlation problem to be dealt with, the other factor of endogeneity might persist. Non-observable characteristics (genes and environment) may still explain lagged weight and current wages simultaneously. More recently, therefore, academics have implemented a differentiating strategy based on fixed-effects models using longitudinal surveys (Cawley 2004) or the existence of another individual with highly correlated genes, such as the anthropometric status of parents, children, same-sex siblings or twins who live separately (Baum and Ford 2004; Johar and Katayama 2012). A fixed-effects strategy eliminates time invariant heterogeneity influencing both weights and wages (particularly genes) but does not deal with unobserved factors that vary over time. Moreover, fixed-effects estimators provide inconsistent results when panel data are based on few waves. Therefore, in line with Cawley (2004), we implement an instrumental variables (IV) strategy based on the random-effects generalized two-stage least squares (G2SLS) estimator. The IV equation (2) takes the following form:

$$B_{it} = \gamma X_{it} + \alpha Z_{it} + \mu_{it} \quad (2)$$

Where the instrument $Z_{it}$ must be a non-weak predictor of the endogenous variable $B_{it}$ (i.e.

[4] The focus on employees is likely to limit the selection correction since inactive individuals, unpaid workers, self-employed workers and employers are treated on the same way. However, given the objective of the study, we consider that this treatment is justified. Any way, results are not sensitive to the change of the base group (inactive and unpaid workers; every work statuses but formal employees; every work statuses but informal employees).

bodyweight) conditional on $X_{it}$ and must satisfy the exclusion restriction assumption (i.e. not to be related directly to the error component in the structural wage equation (1), $Cov[Z_{it}, \varepsilon_{it}] = 0$). Cawley (2004) uses the BMI of a sibling as instrument, but the data on a sibling relationship across households are not available in the MxFLS.

It is commonly accepted in health economics studies that regional data constitute strong instruments for endogenous explanatory variables appearing in individual level equation, especially when other regional variables that affect the dependent variable are controlled for (Wooldridge 2010). For instance, in the case of developing countries, Schultz (2003), Kedir (2008) and Shimokawa (2008) instrument anthropometric status with food market prices in the community in order to explain individual earnings. Nevertheless, food market prices in the community appear to be a weak instrument in the Mexican context (available from the authors on request). Accordingly, as Morris (2007) and Pan et al. (2013), we instrument individual obesity with the prevalence of obesity in the municipality in which the respondent lives. Municipalities are the second-level administrative division in Mexico (the first-level is the state). Each municipality has a council that is responsible to provide all amenities for its population (there is 2438 municipalities in the country).[5] Following Morris (2007), we control for the distribution of obesity in the municipality adding to the set of covariates the number of respondents used to generate the prevalence of obesity and the standard deviation of respondents' BMI in each municipality. Furthermore, since the prevalence of obesity is not an independent source of information and is constructed within sample, it is necessary to adjust the standard errors of all estimates at the municipality level (Moulton 1990).

The evidence suggests that the prevalence of obesity in the municipality satisfies the first requirement of an instrument (i.e. to be highly correlated with individual bodyweight) given the presence of a behavioral link between individual and area obesity (Morris 2007; Pan et al. 2013). Using the terminology of Manski (1993), this link can be considered as exogenous and endogenous peer group effects. First, the environmental characteristics that affect food intake and physical activity of the community members (e.g. availability of supermarkets, fast-foods, sport areas, etc.) may constitute an exogenous peer effect. It is commonly accepted that obesogenic environments can influence the bodyweight of individuals (Swinburn et al. 2011). Even if little is known about the effects of area obesity in Mexico, Villa-Caballero et al. (2006) and Ortiz-Hernández and Janssen (2014) show that neighborhood characteristics (e.g. socioeconomic status, social disorder, etc.) can affect individual bodyweight. Second, the endogenous peer effect of Manski (1993) might refer to the social factors related to the level of obesity among peers. It is not unreasonable to assume that overweight would be considered as the physical norm where the majority of the local population is overweight or obese. For instance, Robinson and Christiansen (2014) identified a social acceptation of overweight in US communities where the prevalence of obesity reached an endemic level. Anyway, the identification of the peer group effect is not the objective of the study. The important point is that the correlation between individual and area obesity is justified theoretically and can be demonstrated empirically. However, the second requirement of an instrument (i.e. the exclusion restriction assumption) cannot be tested directly (Wooldridge 2010).[6] In our application, this means that the prevalence of obesity in the municipality should not directly correlate with individual wages

[5] We assume that the number of respondent is large enough to be representative of each municipality (at least 221 respondents by municipality).

[6] However, as mentioned by Shimokawa (2008), it may be informative to analyze the correlation between residuals $\varepsilon_{it}$ of the wage equation (1) and the instrument $Z_{it}$.

through channels other than the individual bodyweight. Such situation could occur if there are unobserved factors that determine both obesity prevalence and individual wages (e.g. the development level of the county). To neutralize this possible effect, Morris (2007) recommends including a comprehensive set of area deprivation measures. In other words, controlling for the level of development of the municipality, we assume that the prevalence of obesity have no direct effects on wages. Hence, we add to the set of covariates a score of infrastructural development of the municipality given by the highest authority available in the municipality (i.e. the president or the vice-president of the municipality). The score varies from 1 for a low level to 6 for a high level of development.

Insofar as the nature of the causal relationship between bodyweight and wages is still unknown in emerging countries such as Mexico (linear or nonlinear), Shimokawa (2008) proposes to test the robustness of results from the random-effects G2SLS model using a semiparametric partially linear model. The less-restrictive form of this model has two main advantages: (i) to clearly visualize the effect of bodyweight on hourly wages in a plot; (ii) to analyze wage effects, from seriously underweight to severely obese individuals, and not being limited to the cut-off points from the standard classification of bodyweight. In this alternative model, endogeneity problems are corrected using the control function method formulated by Blundell and Powell (2003). The wage equation is now defined as:

$$Y_{it} = \beta X_{it} + F(B_{it}) + \gamma \widehat{\mu_{it}} + \varepsilon_{it} \quad (3)$$

Where F(.) is an unknown function insofar as there is not restrictive linear assumption on the relationship between BMI ($B_{it}$) and log-hourly wages ($Y_{it}$). $\widehat{\mu_{it}}$ is the estimated error term of the IV equation (2).[7] Significant estimated coefficients of $\widehat{\mu_{it}}$ (i.e. $\hat{\gamma}$) could indicate the presence of endogeneity and so might justify the control function method used. This model is said semi-parametric because control variables ($X_{it}$) are regressed parametrically and $B_{it}$ is estimated from a non-parametric Gaussian kernel function. More formally, the partially linear model is based on the following Robinson's (1988) double residual estimator:

$$Y_{it} - E(Y_{it}|B_{it}) = \beta[X_{it} - E(X_{it}|B_{it})] + \gamma[\mu_{it} - E(\mu_{it}|B_{it})] + \varepsilon_{it} \quad (4)$$

The conditional means are non-parametrically estimated using univariate Gaussian Kernel regressions and the coefficients $\beta$ and $\gamma$ are parametrically estimated using OLS. Finally, the function $F(B_{it})$ is obtained by graphing $E(Y_{it}|B_{it}) - \hat{\beta}E(X_{it}|B_{it}) - \hat{\gamma}E(\widehat{\mu_{it}}|B_{it})$ against $B_{it}$.

## 3. RESULTS

Table A.1 of the Appendix presents descriptive statistics of all variables used in the study for the total sample and the restricted sample (i.e. employees only). Among employees, about 2%, 41% and 23% are underweight, overweight and obese, respectively, and, about half of them have no access to formal employment (50% working with formal contracts).

[7] In this model, the IV equation (2) is estimated by an ordinary least square (OLS) estimator.

Table 1: Impact of the instrument on individual BMI

| ***Body-Mass Index (BMI)*** | **All employees** | **Formal** | **Informal** | **Male** | **Female** |
|---|---|---|---|---|---|
| Prevalence of obesity in the municipality | 0.138*** (9.56) | 0.142*** (7.86) | 0.121*** (5.69) | 0.129*** (7.54) | 0.151*** (5.47) |
| Observations | 7127 | 3566 | 3561 | 4464 | 2633 |
| R-square | 0.1536 | 0.2704 | 0.1598 | 0.1433 | 0.1867 |
| Under-identification test | 27.34*** | 24.11*** | 16.06*** | 23.33*** | 16.91*** |
| Weak identification test | 91.38*** | 58.03*** | 33.69*** | 59.689*** | 28.73*** |

Notes: (1) These estimates come from the first-stage of Random-effects G2SLS estimates.
(2) The standard errors are adjusted for municipality level clustering.
(3) Significance levels of coefficients: *** p<0.01; ** p<0.05; * p<0.1. Brackets present robust t-statistics.
(4) All covariates are included: age, age-square, gender, psychosocial distress, schooling, household size, county variables, respondent number and standard deviation of BMI in the municipality.

**Source**: MxFLS (2002-2012).

Concerning the quality of estimations, methodological problems seem to be correctly treated. First, results of the IV equation (2) are reported in Table 1. As expected, even after controlling for all covariates, the prevalence of obesity in the municipality is a highly significant and positive predictor of individual obesity in all gender- and contract-specific subsamples. Moreover, under-identification and weak-identification assumption are both rejected (Table 1). Although it is not possible to prove the exclusion restriction assumption, if the instrument is correlated with the error term of the wage equation (1), it might cast doubt on the validity of the selected instrument. Nonetheless, we do not observe any significant correlation between both variables. Therefore, we assume that the prevalence of obesity in the municipality may constitute a good instrument of individual bodyweight conditional on the set of selected covariates. Second, the fact that the IMR is systematically significant demonstrates the evidence of sample selection bias and justifies our approach. Results from selection regressions are available from the authors on request.

## 3.1. Effects of bodyweight on wages

### *3.1.1. Parametric analysis*

In Table 2, the Chow test suggests a structural break according to the kind of contract. Consequently, three samples are analyzed in this table: (i) all employees; (ii) formal employees; (iii) informal employees. Using the same test, we also observe a break according to gender. Results on gender-specific subsamples are available in Table 3.

In Table 2, all OLS estimates reveal non-significant correlations between bodyweight and wages. Nevertheless, controlling for endogeneity, interesting findings are found according to the kind of contract and gender. In the same table, G2SLS regressions (i.e. the IV model) show a negative and significant effect of BMI on log-hourly wages of formal employees (coefficient of -0.06 at the 5%

level), while this effect appears surprisingly positive but non-significant for employees with an informal contract. No effects are noted when all employees are analyzed together. Furthermore, as demonstrated in rich countries (e.g. Cawley 2004), these effects seem higher for women (Table 3). Only women with formal contracts are significantly affected by wage penalties due to their weight (coefficient of -0.08 at the 5% level). Note that the surprising positive coefficient remains non-significant but increases for female informal employees (coefficient of 0.09 at the 12% level). However, the poor explanatory power of this estimate (R-square of 3.6%) could overstate the coefficient.

Table 2: The impact of BMI on log-hourly wages

| *Ln(hourlywage)* | **All employees** | | **Formal employees** | | **Informal employees** | |
|---|---|---|---|---|---|---|
| | OLS | IV | OLS | IV | OLS | IV |
| Body Mass Index (BMI) | 0.00327 | -0.0160 | 0.00294 | -0.0589** | 0.00415 | 0.0321 |
| | (1.499) | (-0.63) | (1.061) | (-2.00) | (1.363) | (0.73) |
| Age | 0.0854*** | 0.0991*** | 0.0924*** | 0.131*** | 0.0824*** | 0.0633* |
| | (9.321) | (4.69) | (7.408) | (5.09) | (5.869) | (1.83) |
| Age squared | -0.0010*** | -0.0011*** | -0.0010*** | -0.0014*** | -0.0010*** | -0.0008* |
| | (-7.617) | (-4.48) | (-5.898) | (-4.64) | (-5.172) | (-1.94) |
| Gender (male) | 0.385*** | 0.410*** | 0.374*** | 0.437*** | 0.428*** | 0.410*** |
| | (6.587) | (6.00) | (5.494) | (4.93) | (4.595) | (3.90) |
| Psychosocial distress | -0.0087*** | -0.0091*** | -0.0094*** | -0.0090*** | -0.0083*** | -0.0080*** |
| | (-4.545) | (-4.60) | (-3.430) | (-2.94) | (-3.284) | (-3.08) |
| Years of schooling | 0.0630*** | 0.0648*** | 0.0790*** | 0.0798*** | 0.0422*** | 0.0414*** |
| | (17.46) | (17.39) | (17.62) | (16.97) | (10.97) | (10.20) |
| Formal contract | 0.181*** | 0.190*** | | | | |
| | (7.936) | (8.20) | | | | |
| Household size | 0.00266 | 0.00299 | -0.00626 | -0.00423 | 0.00873** | 0.00815* |
| | (0.768) | (0.78) | (-1.350) | (-0.80) | (2.136) | (1.90) |
| High school in municipality | -0.0264 | -0.0215 | -0.0488 | -0.0735 | -0.0245 | -0.0269 |
| | (-0.559) | (-0.44) | (-0.828) | (-1.25) | (-0.434) | (-0.46) |
| Hospital in municipality | 0.0852** | 0.0916** | 0.0953* | 0.129** | 0.104** | 0.0877* |
| | (1.995) | (2.16) | (1.806) | (2.29) | (2.112) | (1.81) |
| Infrastructural development | 0.0128 | 0.0124 | 0.0168 | 0.0121 | 0.00814 | 0.00764 |
| | (0.937) | (0.86) | (0.974) | (0.77) | (0.375) | (0.31) |
| Large community | 0.0820* | 0.0810* | 0.0196 | -0.000948 | 0.149** | 0.152** |
| | (1.730) | (1.64) | (0.382) | (-0.02) | (2.124) | (2.19) |
| Medium community | -0.0943* | -0.102* | -0.0980 | -0.100 | -0.105 | -0.109 |
| | (-1.744) | (-1.83) | (-1.582) | (-1.51) | (-1.524) | (-1.55) |
| Region (south) | -0.184*** | -0.183*** | -0.221*** | -0.195*** | -0.161** | -0.153** |
| | (-4.392) | (-4.17) | (-4.856) | (-4.04) | (-2.563) | (-2.48) |
| Inverse Mills ratio (IMR) | 0.239*** | 0.260*** | 0.279*** | 0.315*** | 0.220*** | 0.198** |
| | (5.383) | (5.05) | (5.165) | (4.78) | (3.256) | (2.41) |
| Respondent number | | -2.94e-06 | | 4.76e-05 | | 6.51e-07 |
| | | (-0.04) | | (0.55) | | (0.01) |

| | | | | | | |
|---|---|---|---|---|---|---|
| SD of BMI in municipality | | 0.00565 | | 0.0369 | | 0.00501 |
| | | (0.17) | | (0.91) | | (0.10) |
| Constant | -0.330 | -0.178 | -0.476 | 0.0890 | -0.0823 | -0.437 |
| | (-1.433) | (-0.56) | (-1.433) | (0.23) | (-0.217) | (-0.75) |
| Observations | 7127 | 7127 | 3566 | 3566 | 3561 | 3561 |
| R-squared | 0.2060 | 0.1957 | 0.2457 | 0.1592 | 0.0886 | 0.0708 |
| Stability (contract) | | 79.085*** | 3031 | | 3194 | |
| (p-value) | | (0.000) | | | | |
| Stability (gender) | | -3.431*** | | -3.616*** | | -5.153*** |
| (p-value) | | (0.000) | | (0.000) | | (0.000) |

Notes: (1) The standard errors are adjusted for municipality level clustering.

(2) Significance levels of coefficients: *** p<0.01; ** p<0.05; * p<0.1. Brackets present robust z-statistics.

**Source**: MxFLS (2002-2012).

Table 3: The impact of BMI on log-hourly wages according to gender and contract

| ***Ln(hourlywage)*** | **Male** | | | **Female** | | |
|---|---|---|---|---|---|---|
| | **All** | **Formal** | **Informal** | **All** | **Formal** | **Informal** |
| Body-Mass Index (BMI) | -0.0040 | -0.0308 | -0.0004 | -0.0244 | -0.0797** | 0.0947 |
| | (-0.12) | (-0.075) | (-0.01) | (-0.75) | (-2.11) | (1.51) |
| Observations | 4464 | 2170 | 2294 | 2663 | 1396 | 1267 |
| R-square | 0.1843 | 0.1910 | 0.0807 | 0.2291 | 0.1636 | 0.0359 |

Notes: (1) Random-effects G2SLS estimators are used.

(2) The standard errors are adjusted for municipality level clustering.

(3) Significance levels of coefficients: *** p<0.01; ** p<0.05; * p<0.1. Brackets present robust z-statistics.

(4) The individual BMI remains instrumented by the prevalence of obesity in the municipality and all covariates are included: age, age-square, psychosocial distress, schooling, household size, county variables, respondent number and standard deviation of BMI in the municipality.

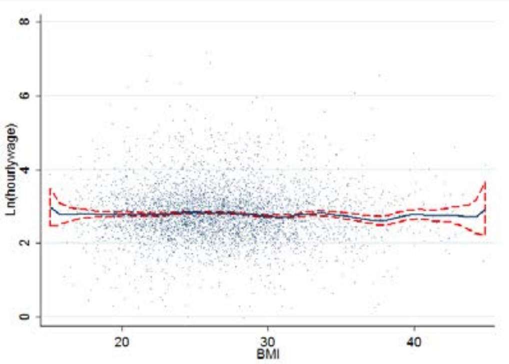
**Source**: MxFLS (2002-2012).

### *3.1.2. Semi-parametric analysis*

In order to check the presence of discontinuity in the relationship and to visually check the robustness of previous findings, we estimate the effect of BMI on log-hourly wages semi-parametrically according to the whole sample and gender- and contract-specific subsamples. Estimates from the structural wage equation (3) are displayed in Table A.2 of the Appendix. Once again, the control procedure for sample selection bias (i.e. Heckman correction) is justified insofar as the coefficients of the IMR are significant in all cases (except for informal female employees). The significance of the coefficient of the estimated residuals of the IV equation (2) (i.e. $\hat{\gamma}$) allows the presence of endogeneity to be tested for. For example, in male subsamples, unobserved factors that affect bodyweight are not correlated with log-hourly wages. By contrast, in female subsamples, the unexplained heterogeneity that affects the individual BMI is significant in the wage equation (3). Therefore, it suggests that, assuming the instrument is valid, the control function procedure treats correctly endogeneity problems for women subsamples only (Wooldridge 2010).

Since $\hat{\gamma}$ is positive and significant in the subsample of formal female employees (at the 10% level), we can conclude that unobserved factors were likely to underestimate the negative effect of individual BMI on log-hourly wages before to implement the IV strategy. It could explain why we do not observe any significant effect in OLS regressions (Table 2).

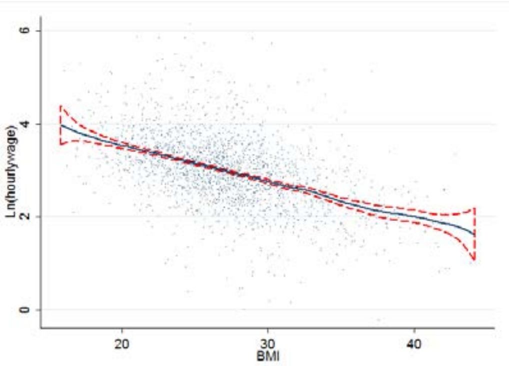
Figure 1: All employees




**Source**: MxFLS (2002-2012).

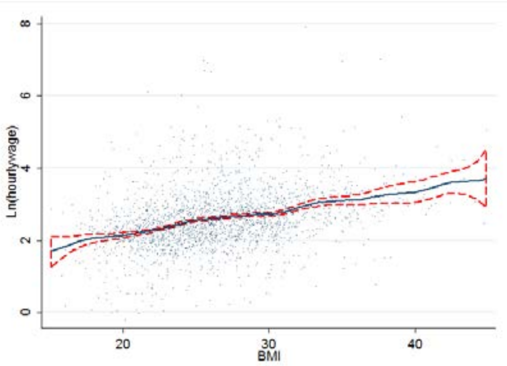
According to Figure 1, the hypothesis of a quadratic relationship between bodyweight and wages, as ascertained by Shimokawa (2008) in China, can be rejected in urban Mexico. Moreover, as previously reported, the individual BMI does not affect the hourly wage when all employees are analyzed together (Figure 1). Referring to Figure 2 and Figure 3, we can assume that this absence of effects in the whole sample is mainly due to reverse bodyweight impacts on wages depending on the kind of contract. Figure 2 shows a negative and linear effect of BMI on log-hourly wage in formal employments, whereas Figure 3 supposes a minor positive and linear causal relationship between both variables.

Figure 2: Formal employees




**Source**: MxFLS (2002-2012).

Figure 3: Informal employees

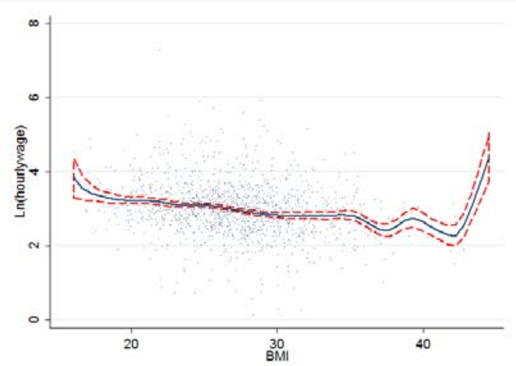



**Source**: MxFLS (2002-2012).

Concerning the gender-specific analysis, results are also similar to previous findings. In formal employments, male employees (Figures 4) seem relatively less subject than female employees (Figure 5) to earning penalties due to their weight.[8] In informal employments, while individual bodyweight do not seem to affect the hourly wages of male workers (Figure 6), Figure 7 reveals a substantial positive impact of BMI on women earnings. However, once again, we denote a relative difficulty in well identifying the earning function for informal employees. For instance, R-squares of the wage equation (3) do not exceed 10% in the subsamples of informal employees (Table A.2 of the Appendix). The weakness of the model in explaining wage gaps among informal employees could possibly overstate this surprising result.

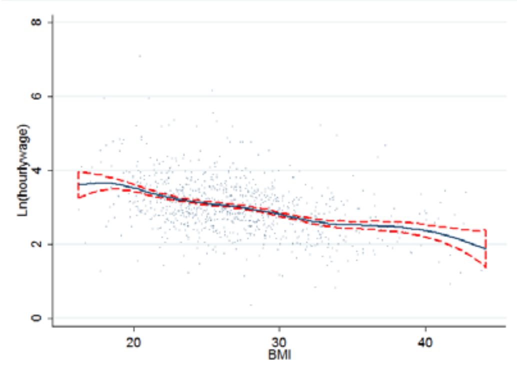
[8] Curves cannot be interpreted when the confident interval (dashed lines) is too large.

Figure 4: Formal male employees



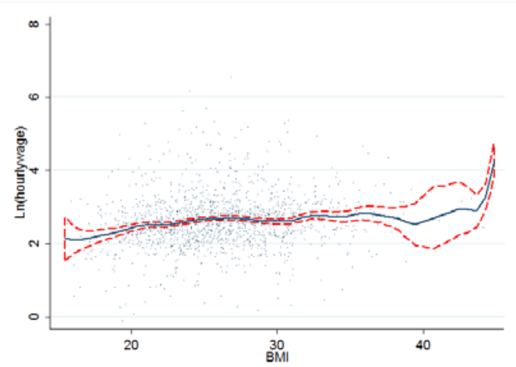

**Source**: MxFLS (2002-2012).

Figure 5: Formal female employees



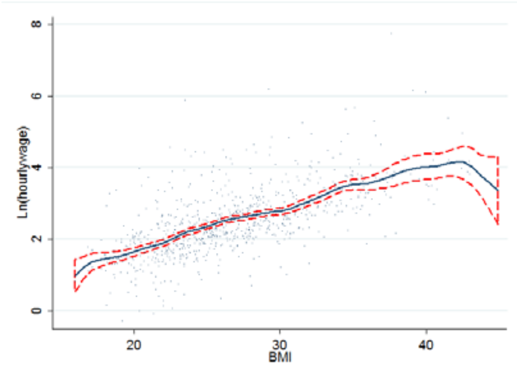

**Source**: MxFLS (2002-2012).

Figure 6: Informal male employees




**Source**: MxFLS (2002-2012).

Figure 7: Informal female employees




**Source**: MxFLS (2002-2012).

### 3.2. Effects of control variables on wages

Effects of control variables on wages are closely similar in the parametric (Table 1) and semi-parametric analyses (Table A.2 of the Appendix)[9] and demonstrate the consistency of our results with the literature in labor economics. As already explained by Chiquiar (2008), living in the south of Mexico tends to be related to lower wages insofar as southern areas are poorer and less urbanized than northern counties. For the same reasons, the size of urban areas and the presence of hospital in the municipality are both factors related to higher levels of wages, particularly among informal employees. Furthermore, Mexican women are paid less than men, age has a quadratic effect on earnings and a higher level of education and having a formal labor contract leads to higher wages. As denoted by Gong et al. (2004), the influence of the age and schooling tends to be higher in formal employments. Finally, in accordance with Mulatu and Schooler (2002), the state of psychosocial distress has a negative effect on earnings.

[9] The only significant difference between both models concerns the variables that identify the household size and the presence of high school in the municipality.

## 4. DISCUSSION

Using panel data from the *Mexican Family Life Survey* (MxFLS), the main purpose of this study was to estimate the effects of bodyweight on wages in urban Mexico. First, we implement a two-stage model, based on an expanded Mincer earning function, to control for potential sample selection bias and endogeneity problems. Second, we combine parametric and semi-parametric regressions in order to determine the nature of the relationship (linear or not). Third, specificities of the Mexican workplace led us to take certain aspects into account. While the effects of obesity on wages usually appear to be related to gender and ethnic origin in rich countries, we assume that in Mexico, and more generally in developing countries, the regulation of employment plays a key role.

The first contribution of this study is that it has identified a difference in causal relationship between bodyweight and wages according to the kind of contract. On the one hand, for employees with formal contracts, BMI tends to have a linear and negative impact on wages, especially for women. On the other hand, we find a positive but non-significant causal relationship between bodyweight and wages for workers with informal contracts, this surprising result concerning women particularly. Note that Cawley (2004) observes the same kind of differences in the United States between white females and black and Hispanic females. According to this author, one possible explanation for such difference is that obesity has a more adverse impact on the self-esteem of white females than on the self-esteem of black and Hispanic females. In other words, obesity would be socially more acceptable for black and Hispanic females than for white females. In the Mexican context, weight-related sociocultural features may explain the difference in results between formal and informal employment for women (Brewis 2003; Pérez-Gil and Romero 2010). One could assume that informal employments seem to constitute a niche sector where Western beauty ideals have not yet been fully adopted and thus overweight and obesity among women are not particularly stigmatized. Perhaps, overweight could be valorized in certain informal activities (e.g. food-related services).[10] However, the difficulty in well identifying the earning function of such informal employments is likely to overstate the observed positive effect. Hence, more studies should focus on wage gaps related to bodyweight in informal employments.

The second contribution of the study is that the hypothesis of a quadratic relationship between bodyweight and wages, as shown by Shimokawa (2008) in China, cannot be generalized across all emerging countries such as Mexico. Two main reasons could explain why this author finds an U-inverted causal relationship. First, China is just at the beginning of the nutrition transition process (Popkin 1993): overweight and obesity rates are relatively low (18 an 2%, respectively), undernutrition persists (5%) and the average BMI raises 23 kg/m$^2$, matching a healthy weight and possibly the Chinese physical norm. Second, as Shimokawa (2008) analyses conjointly rural and urban areas, the quadratic trend observed by this author could be the reflect of economic, nutritional and sociocultural differences between rural and urban China (Xie et al. 2006; Shi et al. 2007).

To summarize, our findings emphasize the complex nutritional situation that exists in emerging economies such as Mexico today. In the formal workplace, the effect of bodyweight on wages is the same that characterizes rich economies. In other words, Western weight preferences seem to be

[10] Since informal women employees tend to work in food-related activities (Allen and Sachs 2007), it would be possible, for example, that employers and/or clients perceive fat cookers as the best qualified for preparing tasty meals.

socially accepted and obese female employees usually earn less money than their slimmer counterparts. Conversely, when the employment is informal, bodyweight has no direct effects on earnings. This result reminds of the situation of poor countries where overweight is not especially discriminated and can be valorized in some cases. Finally, as the impacts of bodyweight on wages seem to depend on gender and work status, we can assume that discrimination and auto-discrimination effects (due to sociocultural beliefs related to weight perception) are higher than productivity effects (due to health problems related to excess weight), at least for Mexican employees in urban areas. Nonetheless, additional research is needed to determine the influence of both effects separately.

## COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that they have no conflict of interest.

**APPENDIX**

Table A.1: Descriptive statistics

| | **Total sample** | | **Restricted sample (employees)** | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| *Employment variables* | | | | |
| Employee | 0.36 | | 1.00 | |
| Formal contract | 0.24 | | 0.50 | |
| Ln(hourlywage) | | | 2.80 | 0.82 |
| *Instruments used for sample selection correction* | | | | |
| In a couple | 0.61 | | 0.61 | |
| Cognitive skills | 52.20 | 25.59 | 54.68 | 23.71 |
| Square of cognitive skills | 3379 | 2619 | 3552 | 2548 |
| Age of the youngest individual | 12.15 | 11.82 | 11.36 | 11.16 |
| Professional training | 0.14 | | 0.16 | |
| Economic dependency | 28.73 | 4.70 | 28.96 | 4.74 |
| Number of elementary schools | 134.21 | 182.14 | 130.43 | 172.11 |
| *Control variables* | | | | |
| Age | 34.54 | 13.10 | 33.31 | 11.79 |
| Age squared | 1365 | 996 | 1248 | 867 |
| Gender (male) | 0.49 | | 0.63 | |
| Psychosocial distress | 5.92 | 5.32 | 5.42 | 4.92 |
| Years of schooling | 12.02 | 4.85 | 12.60 | 4.57 |
| Household size | 5.77 | 2.77 | 5.72 | 2.77 |
| High school in municipality | 0.77 | | 0.79 | |
| Hospital in municipality | 0.71 | | 0.71 | |
| Infrastructural development | 3.63 | 1.04 | 3.69 | 1.07 |
| Small community | 0.20 | | 0.18 | |
| Medium community | 0.17 | | 0.14 | |
| Large community | 0.63 | | 0.68 | |
| Region (south) | 0.18 | | 0.18 | |
| Respondent number | 386 | 252 | 339 | 265 |
| SD of BMI in municipality | 6.33 | 0.58 | 6.37 | 0.52 |
| *Anthropometric indicator* | | | | |
| BMI | 27.32 | 5.38 | 26.79 | 4.74 |
| Obesity prevalence in municipality | 19.28 | 5.64 | 19.69 | 5.85 |
| *Clinical classification of bodyweight* | | | | |
| Underweight | 0.02 | | 0.02 | |
| Normal-weight | 0.33 | | 0.33 | |
| Overweight | 0.38 | | 0.41 | |
| Obesity | 0.27 | | 0.23 | |

Source: MxFLS (2002-2012).

Table A.2: Structural wage equation of the semi-parametric analysis

| ***Ln(hourlywage)*** | **All employees** | **Formal employees** | | | **Informal employees** | | |
|---|---|---|---|---|---|---|---|
| | | Overall | Male | Female | Overall | Male | Female |
| Estimated residuals | 0.0183 | 0.0497** | 0.0297 | 0.0562* | -0.0308 | 0.00106 | -0.0952* |
| | (1.228) | (2.227) | (0.914) | (1.824) | (-1.200) | (0.0347) | (-1.927) |
| Age | 0.0990*** | 0.126*** | 0.109*** | 0.155*** | 0.0606** | 0.0807*** | 0.00883 |
| | (7.134) | (7.383) | (5.090) | (5.888) | (2.440) | (2.938) | (0.194) |
| Age squared | -0.0011*** | -0.0014*** | -0.0012*** | -0.0017*** | -0.0008** | -0.0010*** | -0.0002 |
| | (-6.723) | (-6.849) | (-4.776) | (-5.285) | (-2.530) | (-2.975) | (-0.382) |
| Gender (male) | 0.412*** | 0.438*** | | | 0.400*** | | |
| | (7.437) | (6.114) | | | (4.685) | | |
| Psychosocial distress | -0.0095*** | -0.0100*** | -0.0037 | -0.0169*** | -0.0084*** | -0.0066 | -0.0082* |
| | (-5.270) | (-3.759) | (-0.942) | (-5.866) | (-3.219) | (-1.644) | (-1.894) |
| Years of schooling | 0.0653*** | 0.0838*** | 0.0774*** | 0.0947*** | 0.0418*** | 0.0383*** | 0.0506*** |
| | (24.48) | (25.33) | (19.50) | (16.34) | (9.923) | (6.127) | (9.800) |
| Formal contract | 0.189*** | | | | | | |
| | (10.22) | | | | | | |
| Household size | 0.00404 | -0.00295 | -0.00362 | 0.00397 | 0.00929** | 0.0102* | 0.00682 |
| | (1.466) | (-0.692) | (-0.668) | (0.532) | (2.164) | (1.872) | (0.756) |
| High school in municipality | -0.0284 | -0.0715* | -0.0706 | -0.0757 | -0.0306 | 0.0116 | -0.200** |
| | (-0.899) | (-1.800) | (-1.264) | (-1.285) | (-0.692) | (0.255) | (-2.561) |
| Hospital in municipality | 0.0980*** | 0.120*** | 0.144*** | 0.0885 | 0.0910** | 0.0747 | 0.208** |
| | (2.751) | (3.145) | (2.921) | (1.371) | (1.969) | (1.168) | (2.290) |
| Infrastructural development | 0.0130 | 0.0166 | 0.0106 | 0.0293 | 0.00808 | 0.00386 | 0.0344 |
| | (1.146) | (1.411) | (0.628) | (1.478) | (0.536) | (0.222) | (1.364) |
| Large community | 0.0811** | 0.00355 | 0.0437 | -0.0407 | 0.152*** | 0.149*** | 0.148** |
| | (2.419) | (0.0903) | (0.899) | (-0.500) | (3.657) | (3.313) | (2.110) |
| Medium community | -0.101*** | -0.105** | -0.135** | -0.0541 | -0.104*** | -0.118* | -0.108 |
| | (-2.728) | (-2.293) | (-2.477) | (-0.700) | (-2.616) | (-1.749) | (-1.300) |
| Region (south) | -0.181*** | -0.197*** | -0.191*** | -0.217*** | -0.153*** | -0.147*** | -0.125* |
| | (-8.699) | (-5.355) | (-3.915) | (-4.371) | (-4.053) | (-3.623) | (-1.951) |
| Inverse Mills ratio (IMR) | 0.416*** | 0.490*** | 0.514*** | 0.563*** | 0.311*** | 0.369** | 0.184 |
| | (6.266) | (6.025) | (4.124) | (5.913) | (2.771) | (2.410) | (1.068) |
| Respondent number | 2.79e-07 | 2.82e-05 | 2.83e-05 | 1.01e-05 | 6.49e-06 | 2.33e-05 | -8.77e-05 |
| | (0.00651) | (0.488) | (0.405) | (0.111) | (0.106) | (0.285) | (-0.825) |
| SD of BMI in municipality | 0.00902 | 0.0151 | -0.0442 | 0.0951* | 0.0123 | 0.0576* | -0.107 |
| | (0.390) | (0.564) | (-1.054) | (1.821) | (0.373) | (1.701) | (-1.574) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Observations | 7127 | 3566 | 2170 | 1396 | 3561 | 2294 | 1264 |
| R-squared | 0.196 | 0.239 | 0.213 | 0.297 | 0.084 | 0.076 | 0.095 |

Notes: (1) z-statistics in brackets with bootstrapped and clustered standard deviations at the municipality level.

(2) Significance levels of coefficients: *** p<0.01, ** p<0.05, * p<0.1.

Source: MxFLS (2002-2012).

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